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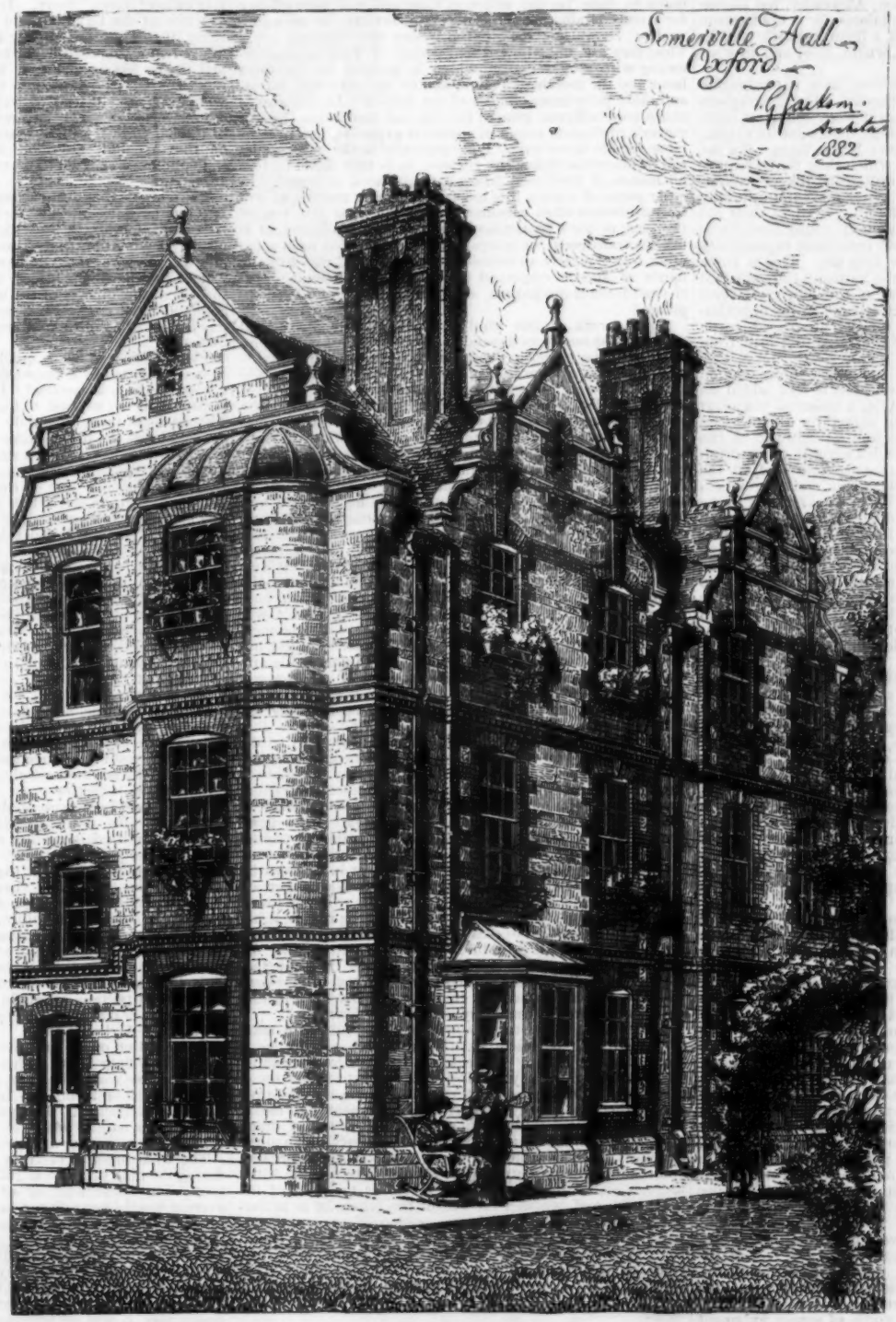
SOMERVILLE HALL, OXFORD.

SOMERVILLE HALL, at Oxford, founded in memory of Mrs. Mary Somerville, was opened for the reception of women students in the October term, 1879. It was started mainly by the efforts of Oxford residents, and is managed by a council, of which the Rev. Mr. Percival, president of Trinity College, is chairman; the principal of the hall being Miss Shaw-Lefevre. The hall was established in an old house with a large garden, near the upper part of St. Giles'; but the number of students speedily outgrew the accommodation so provided. This difficulty has been met by the erection of the new wing, shown in our illustration today, from the designs of Mr. T. G. Jackson, by which additional accommodation is provided for twelve students, and space gained for various improvements in the offices. Mr. Selby, of Oxford, was the contractor, and Mr. E. Long clerk of works—*The Building News.*



SOMERVILLE HALL, FOR WOMEN STUDENTS, OXFORD.

OUR SCIENTIFIC SERVICE.

IN the paths of scientific progress the United States is becoming the leader of the world. There is no other Government in whose name are achieved such results in research, investigation, experiment, exploration, and discovery. The science publications annually issued from the Government printing office make a library respectable in size and invaluable in substance. All branches of knowledge are represented there—geology, geography, astronomy, ethnology, medicine, natural history, agriculture, and engineering. In the century of peace which is before us, while the navy shall rust in idleness, the army shoot the inoffensive target, and the diplomatic corps take French lessons in foreign capitals, the scientist is destined to come to the front, and the names of Franklin, Morse, Agassiz, Henry, Eads, Ericsson, Powell, Walker, and Hilgard will be but the beginning of a long and splendid beadroll which shall be the country's especial pride. Let us now see what inducement the Government offers these men of work and wisdom to devote their talents to its service.

Much of the best public scientific work has been accomplished by assistant surgeons in the army, at $125 a month. There are able astronomers at the Naval Observatory, and fine mathematicians at the Nautical Almanac Office, and zealous workers in the National Museum, who receive no more. According to the Official Register, the highest salaries paid in the scientific corps of the Agricultural Department are those of the chemist and entomologist, $2,000 a year. In medicine a man may receive $10 a day, as a member of the National Board of Health. In architecture the maximum salary is $4,500 a year, that amount being paid to the architect of the Capitol and to the supervising architect of the Treasury Department. Under the supervision of the latter official the federal buildings throughout the United States are designed and constructed. First-class architectural talent is certainly needed in so responsible a position as this, but if it is ever secured it is from some other consideration than that of the salary attached to the office.

No other department of public interests at Washington has conferred upon us greater honor abroad and benefit at home than the Fish Commission. The Commissioner of Fisheries, who is also Director of the National Museum, receives no salary from either of these responsible posts: though the servant of the nation in a double capacity, he is supported from the estate of a foreigner, one Smithson, the founder of the Smithsonian Institution, of which Professor Baird is secretary.

When the present Geological Survey was organized in 1879, its first director, Mr. Clarence King, a man who respects the profession which he so ably represents, placed the government geologists on a respectable footing by making their salaries $4,000 a year. In doing so he complained that the geologist had not hitherto received his fair share of national recognition, but had been made the camp-follower of the various geographical parties which have traversed the West. At the same time he tasted the sweetness of revenge by making the geographer, who alone can give definite shape and usefulness to the geologist's floating knowledge, a camp-follower of the latter at a maximum salary of $3,000 a year. It is always difficult for one profession to recognize that another may be equally deserving. This may not be so much the result of exaggerated self-esteem as of that devotion to one's calling which alone can bring success. To an energetic man his profession is his mistress, and of course to him his mistress is the fairest and best in the world. This influence can be observed in many of the departments of our public service, where the draughtsman and computer are made subordinate to the clerk, the experienced civil engineer is assigned to duty under the fresh young graduate of West Point, the astronomers at the Observatory are overshadowed by the naval officers there, and, in general, one profession exalts itself over another.

The highest salary paid to any one in what may be called our scientific service is $6,000 a year. This sum is given to the superintendent of the Coast Survey and to the Director of the Geological Survey. Let us resort to comparative remuneration in order to discover how highly our savants are esteemed in this country of colleges and common schools. It is an undisputed fact that our judiciary are underpaid, and yet the Chief Justice of the Supreme Court receives $10,500 a year, and he is flanked by a bench full of associate justices at $10,000 each, all of which salaries continue upon the retired list and through life. So much for the lawyer. The business man gets $12,000 a year as Collector of Customs at New York; the sailor may become Admiral of the Navy, at $13,000 a year and perquisites; the soldier may be made General of the Army at $13,500, house-rent, etc.; and the politician, transformed into Minister Plenipotentiary, gets $17,500 a year. Truly, the splendor of the bead-roll heretofore referred to will not be due to any marked favor shown the sciences by the Government.

In reply it is pleaded that large salaries are necessary to our ministers abroad, to enable them to entertain lavishly in the name of the United States, and to live in that princely grandeur which is supposed to be indispensable to those who stand before kings. This specious plea, which appeals to the hospitable instincts of the people, has been found so effective that the naval officers in command of our fleets in foreign waters have taken it up, and would like their pay increased, so that they may supply music, flowers, and refreshment to the nobility of the countries they visit. But while our own sufferers by flood and fire at home are unprovided for, and while our superannuated civil servants at home are pensionless, any large appropriation for the purchase of costly wines for consumption at our legations abroad is mistaken charity. As a matter of policy it is equally a failure. As with men, so with nations, a sincere friendship cannot be bought by an extravagant outlay of money and a liberal giving of dinners. Heart's blood is thicker than the oldest wine, and it is England's sympathy at the time of Garfield's death, and our gifts to her famine-stricken, our Peabody and her Bright, that bind the two countries together close as the mother and child that they are.

On the part of the men of ability, education, and science, who form the subject of this article, it is claimed that their reward is not just, but, if this argument should prove unavailing, then in the potent name of hospitality and good fellowship let them receive greater consideration. When a delegate crosses the sea to Electrical Exposition or Geological Congress, he also may wish to invite his friends to dinner, or, at home to offer shelter to his brethren from abroad. There has been an impression too long that the brain can work best when the body is under conditions of privation and discomfort. The scientist of to-day is different from him of the past, when for chemists we had alchemists, and astrologers instead of astronomers studied the stars, and a crust of bread in a cave satisfied the one, and an attic window was observatory enough for the other. There is no good reason why the man to whom Nature is sister and queen should eat the barren fare of famine, or practice the isolation of the hermit. Hath he not, forsooth, "hands, organs, dimensions, senses, affections, passions fed with the same food, hurt with the same weapons, subject to the same diseases, healed by the same means, warmed and cooled by the same winter and summer?"

If he wishes to dress and live as other people, confessing to the same honest tastes and inclinations, it should be in his power to do so. There are scientific men who can smoke like a first secretary of legation, eat like retired rear-admirals, and drink like a congressman burying his best friend, but they do not indulge in these luxuries out of the proceeds of their Government salaries. If the astronomer, in his midnight vigil in the malarial atmosphere of the Naval Observatory, feels that a cigar would protect his health, his pay should enable him to buy one. Among the dry bones of the Medical Museum it is possible that the doctor might find a glass of wine for luncheon not only pleasant but sustaining. Although the scientist may not have the time and inclination to join the mad medley of fashionable life, he may still be so refined as to object to the soiled napkins and dirty servants of a second-rate Washington boarding-house, and wish for a place in those pleasanter quarters which are considered no more than the just deserts of the *rois fainéants* of the public service. But in order to purchase these amenities of life he will have to forego other things which are more precious than creature comforts, and it will be at the cost of books, instruments, laboratory room, material for experiments, and the like.

The idea that money will spoil a scientific man has become obsolete in this generation of Bells, Edisons, and Copes; and in these days of protective patents it is no longer the fashion to work for humanity at large and leave one's family to starve. True, Louis Agassiz was the author of the famous remark that he had "no time to make money;" and, in consequence, he was often hampered by want of material means to support his researches. His son, Alexander, has chosen the better part, and, devoting his talents for a brief season to money-getting, has accumulated a fortune which enables him to prosecute his studies when, where, how, and to what extent he pleases.

An institution in which Americans have a pardonable pride is the Coast and Geodetic Survey. The geographers and physicists upon its rolls take, as it were, the great earth in their hands; measure its dimensions, determine its weight, and transfer its continents to the map before them. For the special and uncommon knowledge which their duties require it would seem that more than ordinarily liberal salaries would be paid. But it is not so. They are extraordinarily small, very few of the assistants attaining, even in their old age, the pay of one of the multitudinous young lieutenants in the navy, all of whom entertain reasonable expectations of becoming rear-admirals before they die. This is to be doubly regretted, as, aside from the hardship thus imposed upon its own members, the influence of this long-established branch of the scientific service is clearly felt in the organizations of new departments, whose salaries are placed correspondingly low, thus discouraging worthy young men from entering upon the nation's work.

It was once the writer's fortune to know a young man on the Coast Survey who to fine natural talents had added an education such as few receive. After a technical course at one of our best universities, he had served for a time as an instructor in the same. Then he won a fellowship at the Johns Hopkins University, and availed himself of its privileges, supplementing them by further geodetic study in the capitals of Europe. Equipped with this training, he entered the Coast Survey, in which, at the time referred to, he had already served some years, diligently working by day and studying by night to advance himself in his chosen profession. He was able, accomplished, trustworthy, and trusted. His salary was seventy-five dollars a month, the same as is paid to the copyists of the executive departments, who are only required to know how to write and to repeat the creed of the party in power. This copyist, by the way, is simply a man of faith; the man of works, the political manager, would disdain any reward less than a first-class clerkship.

If the patron divinity of the above young man had shaped his ends at West Point, instead of at Cornell and Johns Hopkins, Paris, and Madrid, he would now have been a first lieutenant of engineers, well along toward a captaincy, and receiving double this pay, and his share of that sympathy which the country lavishes upon the underpaid army. It is needless to say that the future did not always look bright to him, but through its darkness came the ray of hope that some day he might be commissioned by some country in South or Central America to introduce our geodetic methods there, and thus find that position and emolument denied him at home. Economical as the system of low salaries may appear at first sight, it certainly is not sound political economy to drive our best talent to sell its services to foreign governments.

Three thousand a year appears to be the maximum limit of the pay of civil engineers working in connection with the War Department, which has an appropriation of about twenty millions of dollars to be expended in engineering enterprises. When, in 1879, Congress organized the Mississippi River Commission to study the ways of that mighty and unmanageable stream and put it under some system of restraint, the two civil engineers of that body were allowed salaries of $8,000 per annum. Eads and Harrod, men of invaluable experience in the hydraulics of the Mississippi, received the questionable compliment of an appointment at these terms. That they accepted is convincing proof to some minds that they are not worth any more, and could not get more elsewhere; but this assumption is absurd to those who know the men and the profession to which they belong. Rather must we conclude that the government, in seeking to purchase their services at this rate, is trading upon their devotion and unselfish interest in that branch of science which is their specialty, and in which they can do most good.

The question of internal improvements, which fall directly in the province of the civil engineer, is now one of the most important before the people, and in the expenditure of the vast sums appropriated annually for that purpose, the best engineering talent, civil as well as military, should be consulted. A thousand dollars' worth of sound judgment and experience may prevent the waste of a million in useless constructions or vain experiments. But men cannot, in general, be expected to work for patriotism and love of science alone; and if a first class engineer accepts a government position at $3,000 per annum, it is at the sacrifice of the $10,000 to $25,000 a year offered him by private corporations engaged in the construction of railways, canals, bridges, tunnels, etc. Or, if wishing to do the work by the piece, he goes to the headquarters of the Government at Washington to make the contract with Congress, whose members are the agents of the people, he is vilified as a lobbyist. Taken all in all, he may be said to receive a minimum share of the public favor; and he, the type of the useful, finds his place at the bottom of the pay-roll, which is headed by the diplomatist of doubtful utility to the country.

Sometimes it is thought and said that the scientific service possesses the advantage of greater stability than that to which entrance is secured through political favor, and which is liable to the vicissitudes of political revolution. On the contrary, the politician's friends are often barnacles of permanency compared with their more scholarly brethren, who are subject to the buffetings of fortune in more ways than one; and no young man should ever permit himself to become a specialist for the Government without weighing well the fact that he is liable to be cut adrift at any time, his accumulation of peculiar knowledge and experience more of a burden than a help to him. Notwithstanding the atmosphere of security which seems to encompass the Coast Survey, it would not surprise the knowing to see it abolished at any time by Congress in some freak of economy, and its members abandoned to the fate of Belisarius the beggar. The present Geological Survey was erected upon the ruins of three similar institutions, rivals of each other. Justice to the individuals concerned and a due regard for the public interest would seem to demand that the new organization should be a union of the old ones, and such was manifestly the intention of Congress, and to this day it is still popularly referred to as a consolidation. That this consolidation was far from complete, however, is the testimony of many worthy veterans of the old surveys, whose unfitness for other work had grown with their fitness for this special business, and who now found this occupation gone.

Many of the civil engineers in government employ, after working with the utmost zeal to complete their reports and maps in time for the action of Congress, are then off pay for a considerable portion of the year, because, to use a convenient formula, "the appropriations are running low." Thus they are not allowed that period of light labor alternating with a busy season which is granted to the farm hand and the merchant's clerk, and to the military, naval, and other permanent officials of the nation. Illness also is considered sufficient ground for removal, and, since the engineer's profession is one of peculiar exposure, his field of labor for the Government lying generally in the most malarial or otherwise unhealthy regions, he is very liable to lose his means of livelihood just when his need is sorest. In other paths of science it is the same, several months of enforced idleness often consuming the savings of the rest of the year; or one's particular branch may be abolished, or it may be transferred, or reorganized, or remodeled, or in some other way "receive an infusion of new blood," which is the figure of speech employed in Washington when an experienced force is discharged, and inexperienced men are appointed.

Again, work of this kind is generally done by special corps, whose members depend for their tenure of office upon the will of the officer in charge, and, since one man's favorites—no offense is meant by the word—are not always the same as those of his successor, it is evident that a change of chiefs will also result in a change in subordinates. If the successive heads of a military department could at pleasure discharge their inferior officers and appoint others without showing cause or giving explanation, it is certain that injustice would sometimes result, and demoralization would ensue. By similar reasoning, the ardent young spirit, fresh from school, may learn that is not safe to build highly upon any fancied permanency in the scientific service until that remote day when corporations shall have consciences, and superiors invested with absolute powers over their subordinates shall realize that, in the scales of justice, their whims and personal likes or dislikes will not weigh against the rightful claim for recognition of an honest and faithful public servant. "My plans for enlarged work this year will oblige me to reduce your salary," was the cool announcement of superior to subordinate on one occasion; it did not seem to occur to him that he had no right to gratify his ambition by "enlarged work" at the expense of a fellow-servant's salary.

So discouraging is the present, and so unpromising the future in some departments of the scientific service, that even a permanent tenure of office is not always to be desired. To become a meteorological observer in the Signal Service, it is necessary to enlist in the army. These observers must, of course, be men of considerable education, and some of them have shown really remarkable ability in their investigations of the phenomena of physical geography; it is but natural that many of them should possess refinement as well, but, in the name of military discipline, they are sometimes subjected to the grossest indignities by the commissioned officer above them, from whom they are separated by the unfathomable gulf of caste. One of them, who had entered the army in ignorance of the full meaning of such a step, desired to escape from this uncongenial bondage. His friends urged him to remain, dwelling upon the advantages of steady employment, which he enjoyed. "Yes," he replied, "and a life-sentence in the penitentiary will also furnish permanent employment; but there comes a time when even permanency ceases to be desirable."

A reasonable desire for money is no discredit to a man, even though he be scientific. Without such a desire, he is worse than an infidel. There can be no true love of family without love of money. "Joy of the street and sorrow of the home," is written of every spendthrift son and improvident father, for money is potential enjoyment. It means books, education, travel, amusement, the power of doing good, pleasant firesides, recreation to the weary, sleep to the careworn, health to the wretched, comfort in the present, and security for the future. To affect to despise the filthy lucre is either the bravado of the fool or the cant of the hypocrite; and, whether the one or the other, he is in danger of the almshouse. The possession of money distinguishes the philanthropist from the tramp; the civilized being from the barbarian; and, too often, the private citizen from the public servant.

FRANK D. Y. CARPENTER.

SOURCES OF IVORY.

IN a report on the cutlery industry of Sheffield, U. S. Consul C. B. Webster gives many interesting facts with regard to ivory, the chief material used for handles. The ivory imported in 1880 amounted to 13,435 cwt., the commercial sources ranging as below:

British East Indies, 2,972 cwt.; west coast of Africa, not designated, 2,310 cwt.; Egypt, 2,083 cwt.; British possession, South Africa, 1,114 cwt.; east coast of Africa, native States, 1,099 cwt.; Aden, 693 cwt.; France, 612 cwt.; Holland, 431 cwt.; Malta, 411 cwt; Portuguese possessions, West Africa, 361 cwt.; British possessions, West Africa, 162 cwt; all other countries, 1,267 cwt.

Malta is the port of shipment to England of ivory that finds its way to Tripoli and other points on the north coast of Africa. To Holland ivory is brought from her possessions on the coast of Africa. France receives but little, except what has been purchased in England, portions of which are sometimes returned. The Bombay, Siam, and Zanzibar ivory is bought for the making of piano keys, carvings, and other expensive articles of luxury.

All ivory from the east coast of Africa, except the Cape, comes through Zanzibar, and pays a royalty to the Sultan. It is known to the trade by a mark, a rude figure of an elephant, that is put upon it after the payment of the royalty. It is said that this mark is sometimes erased from tusks that are to be sent to the United States from the sales in England. Is it to prevent identification when this ivory arrives in our country, and thus to evade the duty chargeable upon "goods the produce of countries of the Cape of Good Hope, when imported from places west of the Cape of Good Hope?"

Mammoth tusks from Siberia occasionally come to the English market, but as they have been lying exposed for centuries, probably for many thousands of years, often buried in ice, the "nature" has gone out of them, and they are not suitable for the cutler's use.

The teeth of the walrus and hippopotamus are used in considerable quantity. Being of suitable size, they are used whole for making expensive carved handles.

Ivory of the best quality comes from the west coast of Africa, under the names Cameroon, Angola, and Gaboon. This is brought down from the interior. It retains a larger proportion of the "fat" or gelatine, from the fact, probably, that it is more recently from the animal. In this state it is called "green" ivory. It is more translucent, and not as white as the Egyptian and other kinds, called "white" ivory, that have been lying a longer time and in a more sandy region, exposed to the heat of the sun, until the animal matter has disappeared. The excellence of the "green" ivory consists in its greater toughness, and in its growing whiter by age, instead of yellow, as is the case with the whiter varieties. Yet buyers of cutlery, through ignorance of these qualities, usually prefer the whiter kinds, which, on that account, are more in demand for the Sheffield trade, and are said to have nearly doubled in price since 1879.

The sales of ivory occur every three months at London and Liverpool. Sales are also held, to a limited extent and at irregular intervals, at Rotterdam. At Liverpool only ivory of the best quality, that from the west coast of Africa, is offered. Buyers from Germany and France, and agents of American consumers, attend these sales. It is estimated that about one quarter of the whole amount sold is taken by Sheffield buyers; another quarter goes to London; the remaining one-half goes to Germany, France, and the United States.

The experienced eye is quick to discern the value of a lot of ivory, assisted by a knowledge of the country from which it comes, which is essential. It is said that the electric light is beginning to be used to test the soundness of the tusks. The stocks of ivory in public warehouses, in this country, are smaller at the present time than for many years, and the rapid advance in prices is a cause of considerable anxiety to manufacturers. The highest price paid at a recent sale in Liverpool, for the best African ivory, was at the rate of $6,740 per ton, or more than $3 per pound. The cost of this material explains the fact that the principal factor in the value of the best table cutlery is the handle.

When the ivory comes into the hands of the cutler, much skill is required to make the most of the precious material. Every scrap is turned to account. After cutting out the scales of all sizes for pocket knives, and the solid handles for table cutlery, the small pieces may be sold to the button makers, or are made into "pearls." Pearls are small pieces of ivory, pearl, or horn inserted into the handles of tea and coffee pots as non-conductors of heat, so called because originally made of pearl.

The fine sawdust is sold for fertilizing purposes, for the making of gelatine, and a fine white sizing for the manufacturers of lace curtains and other fabrics. The refuse still remaining goes to the makers of ivory-black. The proportion of this residuum, dust, and refuse is about ten or fifteen pounds to the hundred-weight, and it sells for eighty to one hundred dollars per ton.

Efforts have been made to devise some method for solidifying ivory dust, but as yet without success.

Skill is required in cutting of ivory, as of wood, to bring out the beauty of the grain. The saw of the cutter occasionally reveals a rifle ball that has been lodged in the tusk and has been completely covered by subsequent growth. About one third of the length of the tusk, where it enters the head of the elephant, is hollow. This hollow, when the tusk is in place upon the live animal, is filled with a soft pulp or core, which supplies the growth of the tusk. A ball lodged in this core will in time become embedded in solid ivory. This hollow portion is cut off and sold separately, except the thinnest portion, as bangle ivory, and is in great demand for bangles or ornamental rings for the ankles and arms of Indian and African women.

That portion of the tusk toward the point is usually more solid and of finer grain. This is cut off and sold by itself at high prices under the name of billiard-ball points.

Small teeth of from 10 to 15 pounds weight are called in the trade scrivelloes. The points of these small tusks are used in their natural state for making handles to expensive carving sets and other articles of luxury.

The total amount of ivory imported into Great Britain during the nine years from 1873 to 1881, inclusive, was 5,286 tons. The whole number of the tusks being known, the average weight per pair can be easily ascertained. This average is put at 40 pounds, which is above rather than below the true weight. Assuming this to be correct, the 5,286 tons of ivory represent 296,016 pairs of tusks, and, consequently, the same number of elephants that have died long ago, or been slaughtered in later times, to supply the demands of luxury for the past nine years. At this rate of destruction it will be seen how rapidly this noble animal must disappear, and how surely ivory will become a thing of the past.

There are, doubtless, large quantities of ivory still remaining in the interior of the African continent, but with the rapid advance of civilized man, and the temptation of increasing high prices, these will be soon discovered and exhausted.

The large proportion of very small tusks brought to market indicates how many elephants die in early youth. To show to what size many of these might have attained, the well known cutlers, Joseph Rogers & Son, of Sheffield, exhibit at their show rooms an African elephant's tusk 9 feet long, 21 inches in girth, weighing 160 pounds. This is among the largest tusks on record. Its present value is $650. An animal large and strong enough to carry such a pair of incisors would attract more attention than Jumbo

A HISTORICAL CLOCK.

OUR engraving represents the magnificent clock once the property of Louis XVI., of France. After the death of that unfortunate monarch this time piece became added to the wonderful collection of the Dukes of Hamilton, in England. Gambling, drinking, and other excesses brought the present Duke of Hamilton deeply into debt, and that he might raise money, the noble paintings, statuary, and other remarkable objects contained in the ducal palace had to be sacrificed,

A HISTORICAL CLOCK.

and were sold a couple of years ago at auction to the highest bidders. Among the articles sold was this historical clock. Its standard is of bronze, in the form of a Roman funereal urn; about it are gracefully entwined two serpents with projecting tongues, which indicate the hours and minutes upon the rotating hour and minute wheels, which are of gold adorned with crystals, as shown in the engraving. The clock brought at the auction $4,500.

The name of Louis XVI., of France, is held in grateful remembrance by all Americans, for he it was who, at the urgent solicitation of our representatives, Benjamin Franklin and Silas Deane, signed a treaty of alliance with the young republic of the United States, February 6, 1798. This led to war between Great Britain and France. The French sent a large fleet, an army, and a liberal loan of money to the United States, and the revolutionary war was soon brought to a triumphant close. The combined American and French forces, under the command of Washington, succeeded in compelling the surrender of Lord Cornwallis and the English army at Yorktown, October 19, 1781, after which there were no further military operations of any note. A preliminary treaty was signed at Paris, November 30, 1782. Final peace and American independence were signed at the court of Louis XVI., at Versailles, September 3, 1783.

The sympathy and generosity extended by Louis XVI. to the United States led not long after to his downfall. His war with England was very costly and ruined the French finances. His grant of aid to the Americans was an act of great popularity in France; but it had the effect to diffuse republican ideas, and was followed by a revolution and mob violence which the good king could not control. He was guillotined in Paris, January 21, 1793. His queen, Marie Antoinette, who was also a most enthusiastic advocate of the American cause, suffered the same death at Paris, October 16, 1793.

Louis XVI. was a man of varied accomplishments. He was fond of mechanism; he became an expert lockmaker, and also a practical printer. He set up the types and printed the sheets for sundry books of his own composition.

He had an extraordinary memory, was industrious, quick to understand, and composed with facility. He was more of a philosopher than a politician. He was a man of simple tastes and habits, of lofty ideas, and admirable principles.

NAIL-MAKERS IN THE BLACK COUNTRY.

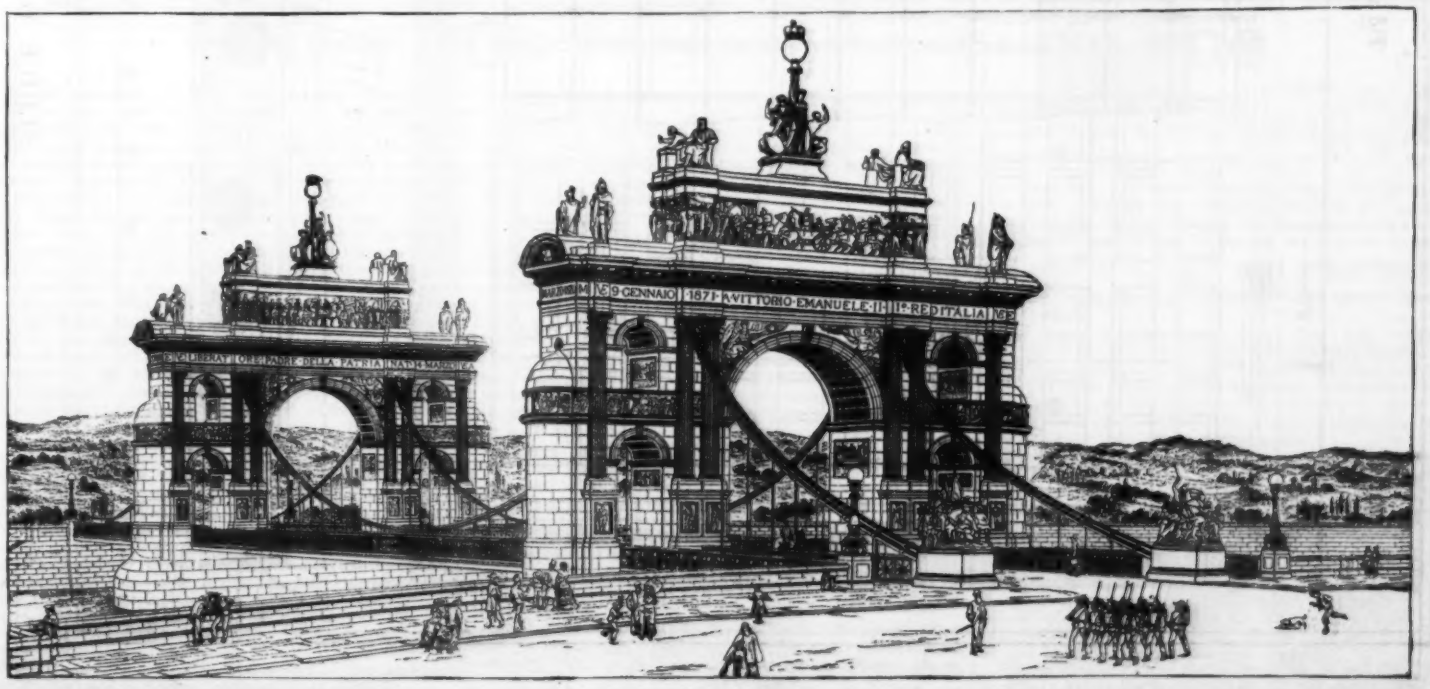
ABOUT 24,000 people are engaged in this dismal part of Great Britain in making nails and rivets. It would not be so much a matter for surprise, even for the lowness of the wages that they earn, if they were all men and youths who are engaged in the industry—one of the very worst paid in any part of the country. But it so happens—and here arises the social degradation of the traffic—that there are at least 16,000 females engaged day after day in the occupation.

They are not all mature women, either; daughters work by the side of mothers—daughters who, in their tender years, ought to be either at home, if they have any home, or in bed, instead of working their weary arms in shaping, in the still, small hours of the morning, molten iron into the form of nails for the benefit of what are called the "foggers."

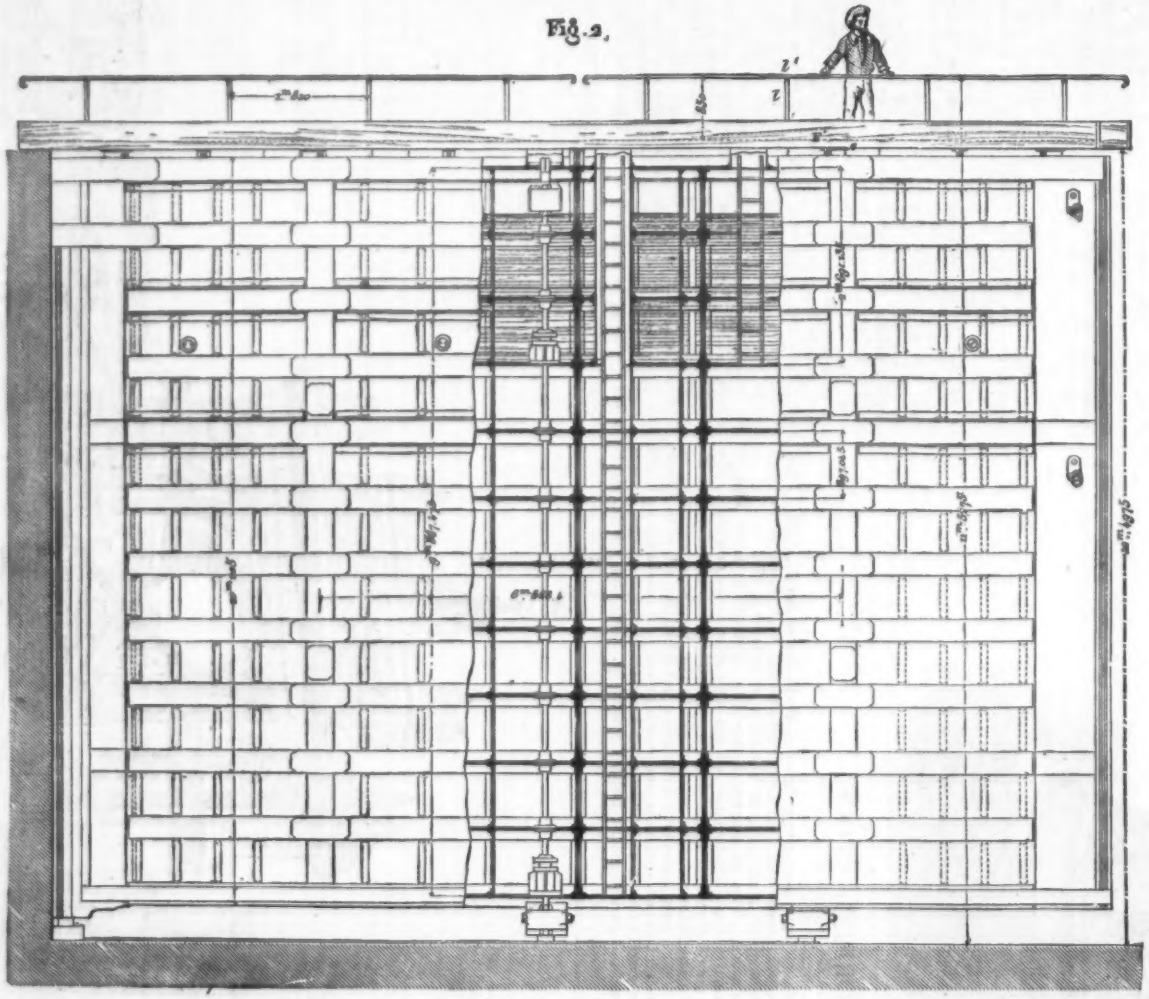
Here is a picture of what may be seen any night in this district—except, perhaps, Saturday nights. In the middle of a shed which adjoins a squalid-looking house there is a whole family at work in the production of these nails; father, mother, sons, and daughters—daughters, too, very young in years, but with that sad look of premature age which is always to be noticed in the faces of child-workers. The gayety of youth, its freshness and its gentleness, seem to be crushed out of them. In the center of the shed, with its raftered ceiling—a bleak and wretched building, through the walls of which the wind readily finds its way—there is a "hearth," fed by "gleds" or breezes. Probably there is a girl or woman blowing at the bellows, while the strips of iron from which the nails are made become molten. Or, to take an actual case witnessed by the writer a few nights since, close upon midnight: In one of these forges were a mother and several children. The mother was a woman probably forty years of age; her youngest daughter—a flaxen-haired girl, with a sweet and winsome face—was certainly not more than twelve years of age. By the side of the hearth there was what is technically called the "Oliver"—a barrel-like construction, on the top of which is fixed the stamp of the particular pattern and size of the nail required to be made.

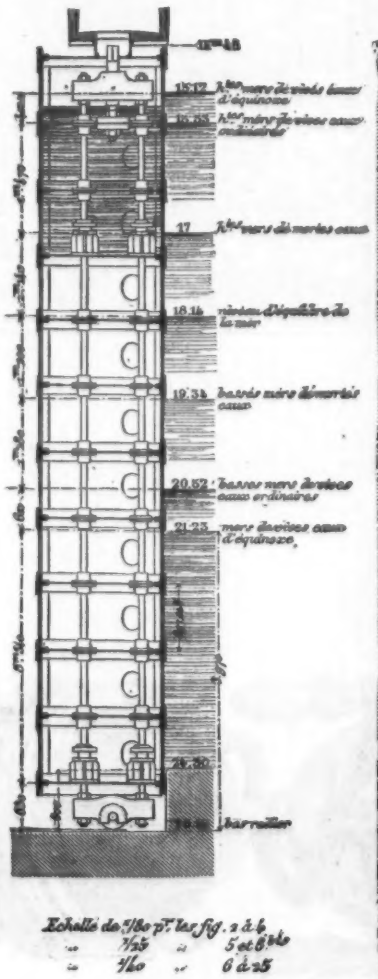
The workmen and workwomen, by means of a wooden treadle—an industrial treadmill it ought more strictly to be called—shoot out the nails from the slot in which they are fixed. They have previously hammered the top of the incandescent metal, with masculine firmness, so as to form the head of the nail. The women and the girls seem to work with more vigor than the men—very often, indeed, they support their husbands and their fathers, who may have fallen into drunken habits; in other cases, this nail-making is the means of supplementing the husband's wages.

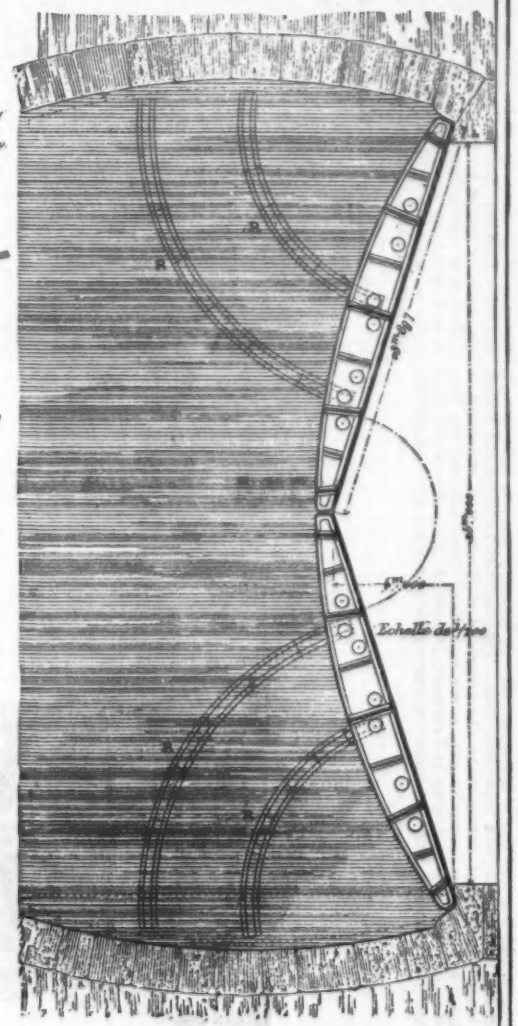
But what do the nail makers earn a week, may naturally be asked? The remuneration they receive is incredibly small. It is no unusual thing—on the contrary, it is rather the usual custom—for a family of three or four persons, after working something like fourteen hours a day, to earn £1 in a week. But out of this money there has to be deducted 1s. 3d. for carriage to convey the nails to the "gaffers," as they are termed in the district; then there is allowance to be made for fuel and the repairing of the machinery, which reduces the £1 to about 16s. 9d. for three people—for three people who have commenced to work every morning at half-past 7 or 8 o'clock, and who have worked on through all the weary day, with no substantial food, until late at night. Who is it that reaps the benefit of all this terribly hard work? Certainly not the laborers; for it is a well-known fact that they rarely taste meat from one week's end to the other. In the expressive but simple language of one poor workwoman, this is how they fare: "When the bread comes hot from the bakehouse oven on Saturday we eat it like raving wolves." The "foggers," or "Tommy shop" men live lives of contentment, profit, and rest at the expense of the poor nail-workers. The "fogger" is an intermediate agent between the worker of nails and the buyer. Out of the bone and sinew of these poor people he makes a very fine living—and he does not work. He has a huckster's shop attached to his dwelling; he supplies, at the beginning of the week,

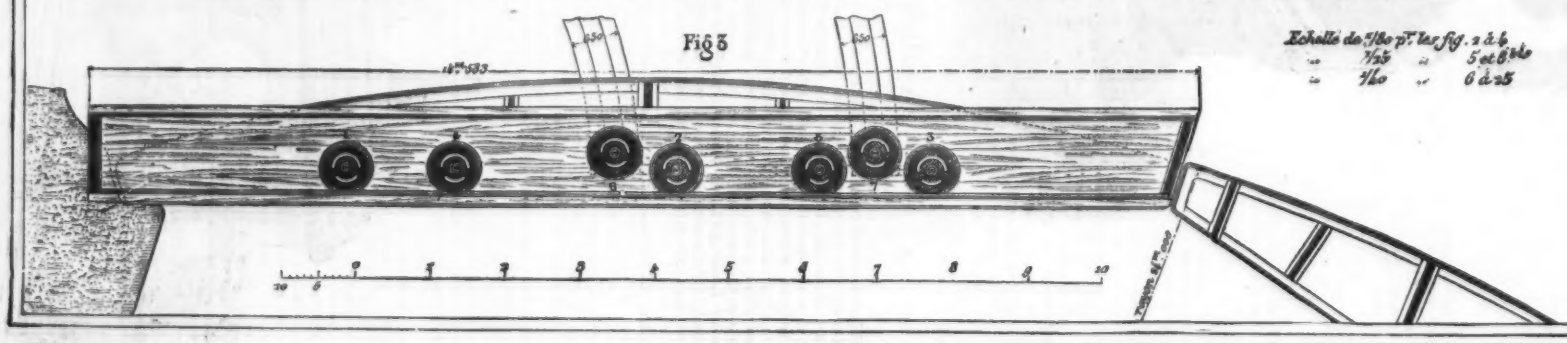


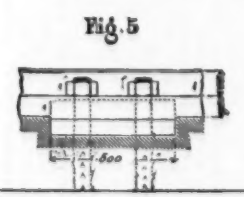
DESIGN FOR THE VICTOR EMANUEL MEMORIAL, ROME.—WILLIAM EMERSON, ARCHITECT; R. ELLIOTT COOPER, ENGINEER.—*From the Architect.*

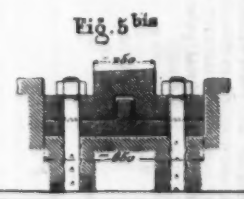












SLUICE GATES OF THE FLOATING DOCK AT SAINT NAZAIRE, FRANCE.

the nail workers with their sixty-pound bundles of iron, and when they return the bundles of iron in the marketable shape of nails—out of which he makes at least twenty per cent. profit—if they do not buy his high-priced provisions, they get no more work from him. These are the men who, by cutting down the workmen's wages to starvation point, are at the root of the evil.—*London Standard.*

THE FLOATING DOCK AT SAINT NAZAIRE, FRANCE.

IT is a well known fact that, in the at present somewhat numerous ports that are unprovided with sluices, ships usually careen at low tide so as to interfere with the operations of loading and unloading. At rising tide, on the contrary, if the waters are forced toward the coast by the wind, they strike against the sides of the ships, and these latter are soon damaged by the alternate immersion and careening. With a view to remedying these grave inconveniences, there have been established in all ports of any importance, arrangements called *floating docks*, which the sea fills at high tide, and in which the water is held back by gates at the lowering of the tide. Between these floating docks and the sea there is always an external port which serves to protect the gates and floating docks from the billows coming from the broad ocean, and as a shelter for small ships.

Maritime sluice gates may be classed under five categories: (1) external or ebb gates; (2) internal gates; (3) flood gates; (4) boat gates; and (5) inlet gates. The purpose of each of these is as follows:

The ebb gates are situated between the external port and the floating docks, and are designed principally to hold back the water in the docks when the sea begins to lower. The sluice gates are placed between two masonry walls, called *chamber walls*, which are wide enough apart to allow of the entrance and exit of vessels. To the right of the gates these walls contain chambers or recesses into which the leaves of the gate enter when the latter is open. Each leaf revolves around a heel post placed vertically in the gate chamber. Between the bottom of the gates and the flow of the sluice there is an interval which facilitates their working. When the two leaves of the gate are closed, they rest against one another through the intermedium of miter posts. To prevent water from flowing out under the gate, and to provide a bearing point for the two leaves, the latter rest at their base against a miter sill. Usually, there are two pairs of gates arranged at a certain distance from one another, and which then include between them the sluice lock that serves to give passage to vessels when the level of the water in the external port and that of the dock are different. The maneuver of the gates is effected by means of four chains, two at one end of the dock and two at the other, which are actuated either by manual power or hydraulic pressure. Filling and emptying are effected in two different ways: (1) by means of paddle valves (as in canal gates), maneuvered from a foot bridge through the intermedium of vertical racks and fixed pinion jacks; and (2) by means of aqueducts formed in the interior of the gate chambers and provided with sliding valves.

The internal gates serve to put two contiguous docks in communication, and are of less importance than the preceding. The object of the flood gates is to prevent the entrance of waves from the sea. They are therefore arranged in an opposite direction from the ones just mentioned.

The boat gates are designed for closing the dry docks into which vessels enter for repair. They serve at the same time as bridges.

Finally, the inlet gates close the sluices of the same name that are designed to prevent accumulations of mud.

It is to the category of the internal gates that put two docks in communication that belong those that we shall examine in some detail in this article.

The width to which sluice gates open was at first fixed at 12 meters; but, with the increase in width of side-wheel steamers, this width has been gradually increased to 25 meters in France and 30 in England. At present, as large side-wheel steamers are being replaced by screw steamers, whose width is less, the opening varies between 16·5 to 22 meters. Nevertheless, all the works at Saint Nazaire, even the new ones, have 25-meter openings, so as to give passage to large war vessels, whose width is greater than that of merchant vessels.

As regards materials for construction, wood was at first exclusively made use of; then cast iron was employed; afterward, iron was associated with wood; and, finally, in the most recent constructions, iron alone is adopted. Such is the case with the gates planned for Saint Nazaire by Mr. Kerviler, engineer in chief of roads and bridges, and constructed by Messrs. Baudet, Donon & Co., of Paris.

A general plan view of the two gate leaves and corresponding chambers of this structure is given in Fig. 1. One of the leaves is seen in elevation in Fig. 2, and a plan of it, with the foot bridge, is shown in Fig. 3.

Fig. 4 is a vertical section on the line of the axis of the lifting mechanism.

Figs. 5 and 5 *bis* show the mode of laying the track in which run the rollers with which each leaf is provided.

The opening between the gate chambers is 25 meters, and the point of the miter sill is 3·17 meters below the lowest equinoctial tides. The height of the leaves, from the miter sill, is 9·7 meters. High equinoctial tides give a difference of level of 6·11 meters, consequently the top of the leaves exceeds such tides by 60 centimeters.

Each leaf may be considered as a species of caisson, closed on all sides, whose vertical outer surface is plane, while the inner is curved according to an arc of a circle having a radius of 24 meters. The two vertical edges of the leaves are sheathed with iron, *t*, 15 to 25 millimeters thick, which is put on when the gates are set up, and which is planed in such a way as to make as tight a joint as possible between the two leaves, and between these and the gate chambers. Each leaf is divided into eleven compartments by horizontal girders, A, connected by uprights, M (numbered from 1 to 7), by cross-stays, E (1 to 14), and by two posts, T and B. In the direction of the height, each leaf is divided by horizontal tight partitions into two chambers, to wit: (1) An *air chamber*, below, comprising eight compartments and having a height of 7·176 meters from axis to axis of the iron plates. (2) A *water chamber*, above, comprising the three other compartments, having together a height of 2·691 meters.

The leaf, consequently, has a total height of 9·8675 meters, measured from axis to axis of the extreme girders. All the compartments are 897·045 millimeters in height. The length of the leaves, measured along the miter sill, from the angle of the gate chamber to the center of the sill, is 13·697 meters. The sill projects 0·8 of a meter from the sluice floor, and its pitch is 4 meters per 25 meters of span, or a little more than a sixth of the opening.

The Horizontal Girders (Figs. 6 and 8).—These girders are all alike, and consist of a web, A, 15 millimeters in thickness, of four angle irons, *a*, of $\frac{120\times160}{15}$, and of two plat-bands, *a'*, of 350×15, placed over the iron plate, *p*, of the vertical sides, and thus serving as joint-cover to the said plate, whose thickness is 12 millimeters.

The width of the webs in the middle is 1·68 meters. They are in five pieces, connected by double joint-covers of 160×15. The angle irons are likewise in several pieces, connected by joint-covers of $\frac{140\times140}{14\cdot5}$. The rivets of the different parts are spaced 90 millimeters apart, and their diameter is 25 millimeters.

The lower girder is made in the same way as the others, but its web is 20 millimeters in thickness. The webs contain several circular apertures, O, which serve the following purposes: Those bearing the numbers 1, 2, and 3 give passage to ladders, *o*, which permit of the lower part of the gate being reached. Those numbered 4 and 5, through which pass the ladder, o^1, give access to the three compartments of the water chamber. Those numbered 6 and 7 contain the rods of the lifting mechanism and also receive the guides of the latter.

The vertical sides which serve to connect the different girders with the heel and miter posts are shown in horizontal section in Figs. 12 and 15, and in vertical section and elevation in Figs. 9 and 11, on the one hand, and in Fig. 14 on the other. They consist of an iron plate, T^1, of 15 millimeters, containing ellipsoidal apertures. This plate is connected with those placed in the prolongation of the webs of the different girders by angle irons, *r*, of $\frac{90\times90}{11\cdot5}$. With the plane and curved sides, *p* and p^1, of the gate, it is connected through the intermedium of a sheathing of 10 millimeters put on externally and performing the role of a joint covering.

The Uprights and Cross-stays.—By reason of their importance, these parts had to be constructed under the best conditions that their system allowed. It was necessary, on the one hand, to interrupt the upright pieces so as not to interfere with the continuity of the horizontal girders, and, on another hand, proper provision had to be made in the partitions of these braces to permit of a free circulation in the compartments.

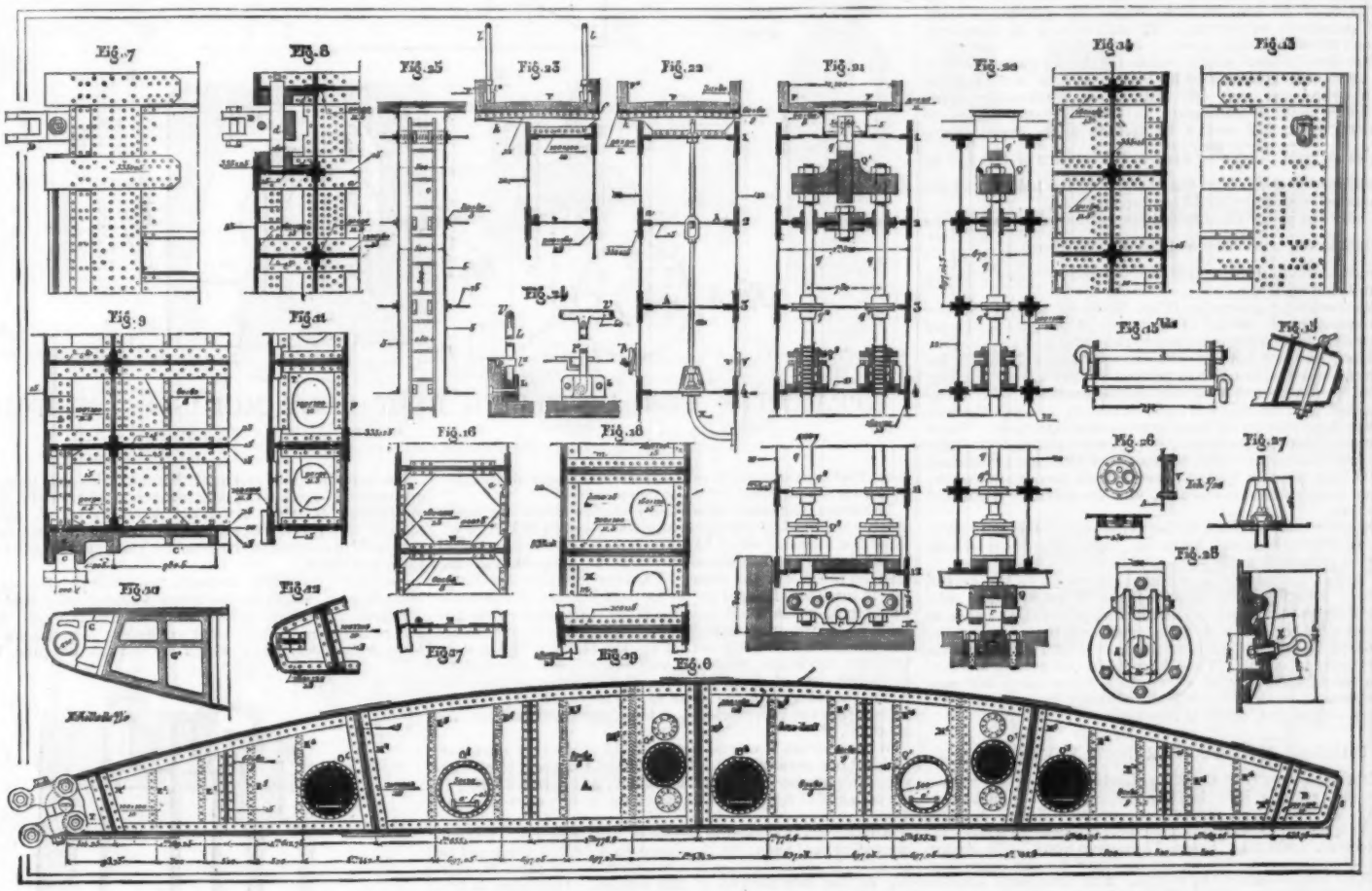
In order to satisfy such conditions, the arrangement shown in Figs. 18 and 19 was adopted for the uprights, and that shown in Figs. 16 and 17 for the cross-stays. The uprights consist of a web, M, of 15 millimeters, connected with the girders by horizontal angle irons, *m*, of $\frac{160\times120}{15}$, fixed on linings of 335 × 15 by two rows of rivets, 25 millimeters in diameter. Besides these uprights, which are 17 in number, there are also 14 cross-braces, which are much lighter, and which are composed of horizontal angle irons, E, and of vertical ones, E^1, of $\frac{60\times60}{8}$, united by angle-braces, *e*, of 200 × 8, by means of 16-millimeter rivets spaced 100 millimeters apart.

The Socket and Pivot (Figs. 9 and 10).—The socket or bearing, C, is a large piece of cast steel firmly bolted to the lowermost girder, to which is likewise fixed a cast iron plate, C^1. The pivot hole is 220 millimeters in diameter. This bearing is surmounted by two iron braces, *g*, whose long vertical branch is riveted to the post at a height that corresponds to the two lower compartments.

The pivot, *c*, is of cast steel, and it and the bearing are made eccentric with respect to the quarter circle of the gate chamber, so that, as soon as the gates begin to open, the surfaces in contact shall separate from each other and give rise to no friction.

The Upper Journal (Figs. 7 and 8).—This consists of a strong steel pin, *d*, 160 millimeters in diameter, held by two cast iron plates, d^1, which are affixed to the two upper girders. This pin runs through a collar, D, formed of three pieces, as may be seen in Fig. 6. This collar is fixed at the extremities of two anchoring pieces that are firmly embedded in the masonry of the gate chamber.

The Rollers and Lifting Mechanism (Figs. 20 and 21).—Each gate leaf rests on the floor through the intermedium of two conical rollers, *r*, which, while the gates are maneuvered,



SLUICE GATES OF THE FLOATING DOCK AT SAINT NAZAIRE, FRANCE.

each follow a track, R, set into the flooring, and the details of which are shown in Fig. 5.

The axle of each of these rollers revolves in a cast steel bearing, Q, forming a connection between two vertical rods, *q*, which ascend to the upper compartment and are connected there by a steel piece, Q^1, of the same form as the bearing below. This piece or cap is traversed by a strong screw, q^2, that may be revolved by means of a socket-key. A means is thus afforded of causing the rods to ascend or descend in their cast iron guides, q^3. To the right of the girders, 4 and 12, which form tight partitions, the guides are replaced by stuffing boxes, Q^2, as may be seen in the section in Figs. 20 and 21. To render the joint as perfect as possible the rods are surrounded by a bronze bushing. By means of this mechanism the position of the gates may be so regulated as to bring about a contact throughout the whole extent of the miter posts.

The regulating rods are 100 millimeters in diameter, and the track, which is formed of seven cast iron segments, is 250 millimeters in width by 100 in thickness.

The Foot-bridge (Figs. 21 to 24).—Each leaf is surmounted by a foot-bridge, F, supported by small brackets, *k*. This bridge, which is 1·1 meters in width, consists of five planks 80 millimeters in thickness laid upon slightly arched angle irons, which are affixed to the brackets by rivets. On each side of the bridge there are arranged two longitudinal angle irons, each of which receives a plank, F^1, 310 × 80. Against these planks are fixed the uprights of the hand-rail. The uprights, which are eight in number in each leaf, and are spaced 1·82 meters apart, are not affixed directly to the planks, but hinge upon a bolt or pin belonging to a cast iron piece, L, which is bolted to the plank. This arrangement (shown in Fig. 24) allows the uprights to fall on to the plank. When the hand-rail is raised, it is kept in that position by four catches, F^2. When it is lowered, no piece exceeds the masonry of the chamber walls.

Ladders (Figs. 6 and 25).—The ladders consist of two uprights, *o*, of flat iron, 20 × 50, placed 250 millimeters apart and connected by rounds, *o*, 25 millimeters in diameter, spaced 300 millimeters apart.

The three ladders which run to the lower girder traverse the three compartments of the water chamber in the interior of a cylindrical well 500 millimeters in diameter made of boiler plate 5 milimeters in thickness and affixed to girders Nos. 1, 2, 3, and 4 by double angle irons. Rectangles of iron, $\frac{60 \times 80}{9}$, fixed in the interior of the well by 16-millimeter bolts, hold the uprights of the ladder, and are connected with these by 12-millimeter bolts.

Under the water chamber, these ladders are fixed to the girders through the intermedium of angle irons of $\frac{80 \times 80}{10}$.

The entrance to these well holes is closed by a cast iron cap 20 millimeters thick.

Maneuvering Apparatus (Figs. 15, 15 *bis*, and 26 to 28).—The opening and closing of the leaves of the gate is effected by drawing on chains attached to the miter posts.

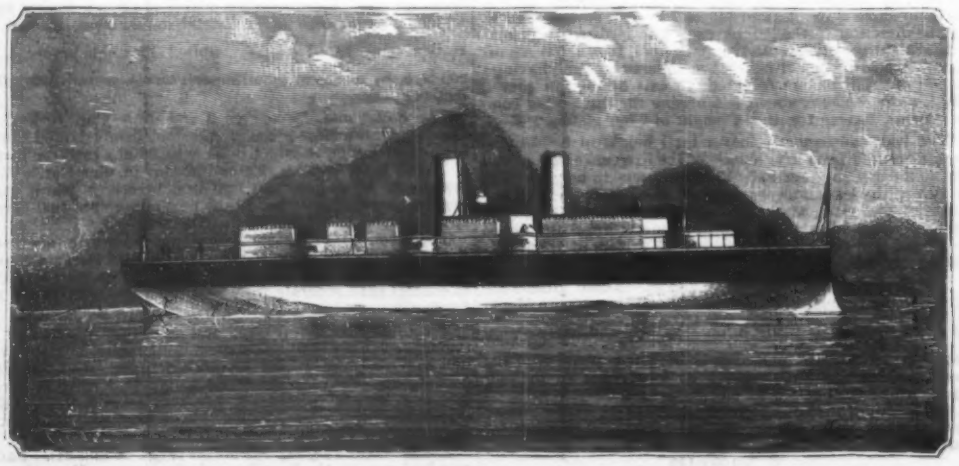
When the level of the sea exceeds girder No. 4, it becomes necessary, in order to prevent the gates from floating, to allow water to enter the compartments of the water chamber. To do this it is only necessary to open the four valves, A, placed on the inner curved side of the gate. These valves are shown in section and front view in Fig. 28. They are kept raised or closed by means of rods that are maneuvered from the foot bridge. The aperture through which the water is introduced is circular, and its diameter is 100 millimeters.

Opposite these valves, in the plane side of the gate, there are apertures, *o*, closed by bronze valves, V, whose details may be seen in Fig. 26.

The water chamber is emptied by valves on the curved sides of the gate, or by special pipes, X, on the plane side. One of these pipes may be seen in Fig. 22. It debouches on a level with girder No. 4, and its aperture may be closed or rendered free by displacing a plug, x^1, which terminates the maneuvering rod, *x*. This latter is in two parts connected by a screw, the lower of which does not revolve but may be displaced vertically, while the contrary happens with the upper.—*Machines, Outils et Appareils.*

CHILIAN MAN-OF-WAR NEW ESMERALDA.

THE government of Chili has lately added to its navy a new and powerful iron-clad steamer called the New Esmeralda. The principal dimensions are as follows: Length, 290 feet; width, 43 feet; depth, 29 feet; draught, 18½ feet; displacement, 2,920 tons. Speed, 17 miles an hour. *La Ilustracion Española*, to which we are indebted for our engraving, gives no particulars of the engine. The armament consists of two 24 ton guns, 10-inch bore, wire wound, one at bow, one at stern; in addition there is a battery of six 4-ton guns, 6 inch bore. The ship is armored with steel plates, has inclined turrets; the front and rear batteries, where the large guns are located, are strongly made with steel beams, forming a very solid protection for the gunners. The bow is armed with a formidable ram that extends forward under water, and is composed of steel bars; the latest inventions have been employed in every part of the vessel, and she forms a splendid specimen of naval architecture.



THE CHILIAN WAR SHIP NEW ESMERALDA.

APPARATUS FOR THE CARBONIZATION AND DISTILLATION OF THE RESIDUA OF BEET-ROOT MOLASSES.

THE apparatus employed by Messrs. Lederer & Gintl (German patent, No. 17,874) for the continuous distillation and carbonization of the products of distillation (*vinasses*) of beet-root molasses consists, as shown in Figs. 1, 2, 3 and 4, of a plate iron drum, A, whose two ends carry the iron tubes, B, by means of which it revolves in the bearings, C. The fixed tube, G, closed at its two extremities, is provided at these points with tubes, B, lined with asbestos. The upper part of this tube, G, is open along the length of the drum and carries a strong iron wing, H, whose extremity is furnished with a scraper touching the internal surface of the drum, and arranged obliquely with respect to the direction of the rotary motion. The drum is placed in a furnace in which the flame is turned by a high fire bridge, and revolves the drum in a direction opposite its own, while the gases that are disengaged are led around the part of the tube, G, which is connected with the receptacle, N.

The drum receives a slow rotary motion from the screw gearing, S, until its temperature has risen to 300° or 350°. Then the *vinasse*, which has previously been concentrated to 40° Baume, is introduced through the pipe, M, running into the interior of the drum. The layer of about 3 millimeters in thickness formed on the internal surface of the drum undergoes, in the rotation of the latter, the action of the fire more and more, and distills. The methylated and ammoniacal compounds which are given off are led through the pipe, L, into the condenser, while the carbonized crust is separated by the scraper, H, from the sides of the drum and descends along the wing into the tube, G. The screw, J, leads the carbon into the receptacle, N, which is emptied through the aperture, P.

With a drum 2 meters long and 1·5 meters in diameter, making one revolution per ten minutes, 163 liters of concentrated *vinasse* per hour may be treated, this corresponding to a treatment of 3,880 liters, or 50 cubic meters of *vinasse* per day.

Another arrangement is shown in Figs. 3 and 4. The upper cylindrical reservoir, A, closed by a cap, is traversed by an axle, B, made tight, and in which passes a pipe, M, serving for the introduction of the *vinasse*. This pipe is prolonged along the arm, R, of the axle, B (which is set in motion by the wheel, E), or into the reservoir, A. The arm, R, carries, in the direction of its motion, a scraper, H, shaped like a plowshare, which separates the carbonized crust from the bottom of the reservoir and causes it to fall through an aperture into a closed receptacle, N. The *vinasse* flows over the bottom of the reservoir, A, through apertures in the pipe, M, on the side of the arm, R, opposite the scraper, H. The volatile products of the distribution are disengaged through the pipe, L.—*Dingler's Polytechnisches Journal.*

KOERTING'S ASPIRATO-CONDENSER.

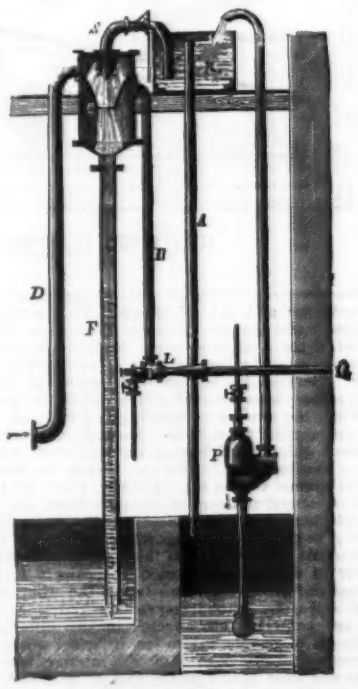
As a substitute for the piston pumps of vacuum evaporating apparatus employed in the manufacture of sugar and chemical products, the Messrs. Koerting have devised an aspirato-condenser which we represent herewith. The different letters in the cut designate the various parts, as follows:

L. Air aspirator.
V. Steam port of the air aspirator.
C. Condenser.
D. Steam escape pipe.
H. Suction-pipe.
F. Discharge-pipe, 10 meters in length.
S. Siphon.
A. Waste-pipe.
R. Reservoir.
G. pipe for the escape of steam from the aspirator, L.
P. Direct-acting pulso meter.

APPARATUS FOR DISTILLING BEET ROOT MOLASSES RESIDUA.

The aspirator is so arranged that with the steam index alone a vacuum of from 64 to 65 centimeters of mercury may be maintained at will. After the steam valve, V, has been opened to its full extent, the position of the said index is regulated according to the pressure existing, and the vacuum to be produced.

Beginning with this moment, the vacuum effected in the condenser, C, sucks up the water automatically that serves for condensation and forces it into the reservoir, R, through the pulsometer. This water condenses the vapors of the evaporating apparatus which are led by the pipe, D, and



KOERTING'S ASPIRATO-CONDENSER.

afterward flows through the discharge-pipe, F, while the aspirator, L, extracts the permanent gases which cannot be condensed and carries them, mixed with the direct steam, into the pipe, G. From thence they may circulate in the interior of a heating pipe, provided that the resistance to be overcome does not give a pressure above that of the atmosphere.

As may be seen, the manufacturers likewise substitute for the cold water pump a direct acting pulsometer, which, as arranged as shown in the cut, raises the temperature of the

feed-water by about 2 5°. The effective performance of the latter is, then, not lessened through the condensation of the steam.

This apparatus is capable of numerous applications. It may even be used as an auxiliary aid in such installations as already exist, thanks to its low price and its regular operation.—*Revue Industrielle.*

A SMALL OSCILLATING MOTOR FOR ACTUATING A PUMP.

IN the accompanying plate, we illustrate a small steam motor for actuating a pump, manufactured by the firm of Sautter, Lemonnier & Co., of Paris.

The motor and the pump (Figs. 1 to 5) are arranged vertically upon a single cast iron plate, bolted firmly along the wall, as seen in Fig. 1, which is a front elevation, the cover of the slide valve box being removed. Fig. 2 is a plan of the pump in horizontal section, on the line 5–6.

The motor is shown on a larger scale in lateral elevation in Fig. 3; in horizontal section on the line 1–2, in Fig. 4; and in vertical section through the axis, 3–4, in Fig. 5.

The engine consists of an oscillating cylinder, C, with which are cast in a piece two appendages that serve as trunnions and that are supported by the prolongation of the lateral cheeks of the hollow frame, B. The latter, forming a bracket at the upper part, supports the pillar blocks of the crank shaft, A, which carries at one extremity a fly-wheel, A^1, and at the other a pinion, *a*. The cylinder trunnions are hollow, and serve, as usual in such cases, as conduits for the entrance and exit of steam.

The piston, P, is forged with the rod, *p*, and carries channels that receive two steel springs. To the extremity of the rod is keyed the head, p^1, in two parts embracing the crank of the shaft, A.

The cylindrical valve, *t*, is mounted upon an axle, t^1, capable of revolving in two bearings fixed in the sides of the valve box, which latter is closed by the cover, t^2. The axle, t^1, is actuated by the lever, T^1, which is itself, through the intermedium of the piece, *b*, articulated with the extremity of the crank, T. This latter receives its motion from an eccentric, T^2 keyed upon the shaft, A, at an angle of about 104°. The position of the valve may be changed, moreover, by acting upon the nuts which hold the piece, *b*.

In Fig. 4, there may be seen a small roller, *g*. This, during the oscillation of the cylinder, rolls over a steel band *g*, and prevents any lateral displacement of the plane of oscillation. By this means, such losses in work as would occur through the friction developed on the trunnions by the steam under pressure are considerably reduced.

The power of this motor at 5 atmospheres is that of 5 horses.

The Pump (Figs. 1 and 2).—The pump, which might serve as a hydraulic motor, differs from the steam motor, in arrangement, only in the mode of distribution.

The lever, D^1, which is mounted at the extremity of the axle, d^1, of the valve, *d*, terminates in a cylindrical rod that freely traverses a steel ball which plays within a socket, D^2, formed of two parts that are connected by bolts. This socket is held by a rod, D^3, which is fixed to the extremity of the support, D^4, and bolted to the side of the frame. As may be seen, when the cylinder oscillates and carries along the valve, *d*, and rod, d^2, the extremity of the lever, D, will slide in the ball and oblige the latter to revolve in its fixed support, and this will result in the displacement of the slide, *d* which will thus effect the distribution.

When employed as a hydraulic motor, this pump presents the advantage that it will operate without any shock, under all pressures—from those corresponding to a head of two meters up to the highest pressures afforded by accumulators. It works just as well in making but a few revolutions per minute as with a velocity of 3 0 revolutions.

The displacement of the valve with respect to the orifices is hastened at the beginning of the opening and closing of them, and retarded when the valve has already uncovered them. It is this peculiarity of the system that permits of great velocity being obtained.—*Machines, Outils et Appareils.*

MEGY'S TOTALIZING DYNAMOMETER.

A GENERAL view of the totalizing dynamometer, devised by Mr. Mégy, is given in Fig. 6 of the accompanying plate. This apparatus gives by a simple reading of the number registered on the counter, and by the multiplication of this number by a constant coefficient, the power in kilogrammes transmitted by the motor to the machine to be tested.

It consists of a shaft, A, revolving in two bearings, *b*, supported by the frame, B, and to the extremity of which is keyed a pulley, P, over which passes the driving belt. A second pulley, Q, embraced by the belt which transmits motion to the machine to be tested, is mounted loose upon this shaft, as in the Morin dynamometer. When the shaft, A, revolves, it carries along a sleeve, *c*, containing four mortises designed to receive the flat springs, R, that are held in place by keys and bolts. These details may be studied in the transverse section in Fig. 9.

The extremity of each of the springs, R, carries at each side two small plates, *r*, between which is held another flat spring, S, opposite the first. The springs of this second series are fixed in the same way as those of the first, on the prolongation, *d*, of the center of the pulley, Q, which latter, in addition, carries two projections through which pass the rods, *t*. When the shaft, A, is set in motion, it begins by carrying along the sleeve, *c*, and the series of springs, R, which curve, as well as the springs, S, until the resistance of the machine to be tested being overcome, the pulley, Q, begins its motion. It is this bending of the springs, which is proportional to the resistance of the machine, that it becomes a question to cause the apparatus to register.

To effect this, the sleeve, *c*, is prolonged and carries a bronze bushing, *c'*, provided with a thread of wide pitch. This thread engages with another similar one in the interior of the sleeve, D, which is loose on the shaft, A, and which carries projections that are freely traversed by the rods, *t* (Fig. 7).

The socket, *c'*, belonging to the sleeve, *c*, to which the springs, R, are fixed, and, on another hand, the sleeve, D, being connected with the center of the pulley, Q, through the rods, *t*, it will be seen that every bend of the springs will cause D to revolve upon *c*, and, because of the threading, will make it move in the direction of the axis of the shaft, A. This longitudinal displacement will be proportional to the bending of the springs, and, consequently, to the stress transmitted.

In order to transmit this displacement to the registering apparatus, the sleeve, D is embraced by a collar, *e*, held between the two arms of a forked lever, E, capable of oscillating on an axle supported by a bracket connected with the box, F, of the registering apparatus.

The lower extremity of the lever, E, acts upon an axle, g^1, which carries at the center a steel disk, *g*, which, in a state of rest, bears with slight friction against the disk, *f*, to whose center it is tangent (Figs. 7 and 8). When in motion, the disk, *f*, which is toothed at its periphery, revolves with a speed proportional to that of the shaft, A; motion being transmitted to it from the latter through the intermedium of the wheels, *a*, a^1, of the pinions, a^2, and of the straight pinions, a^3, and a^4.

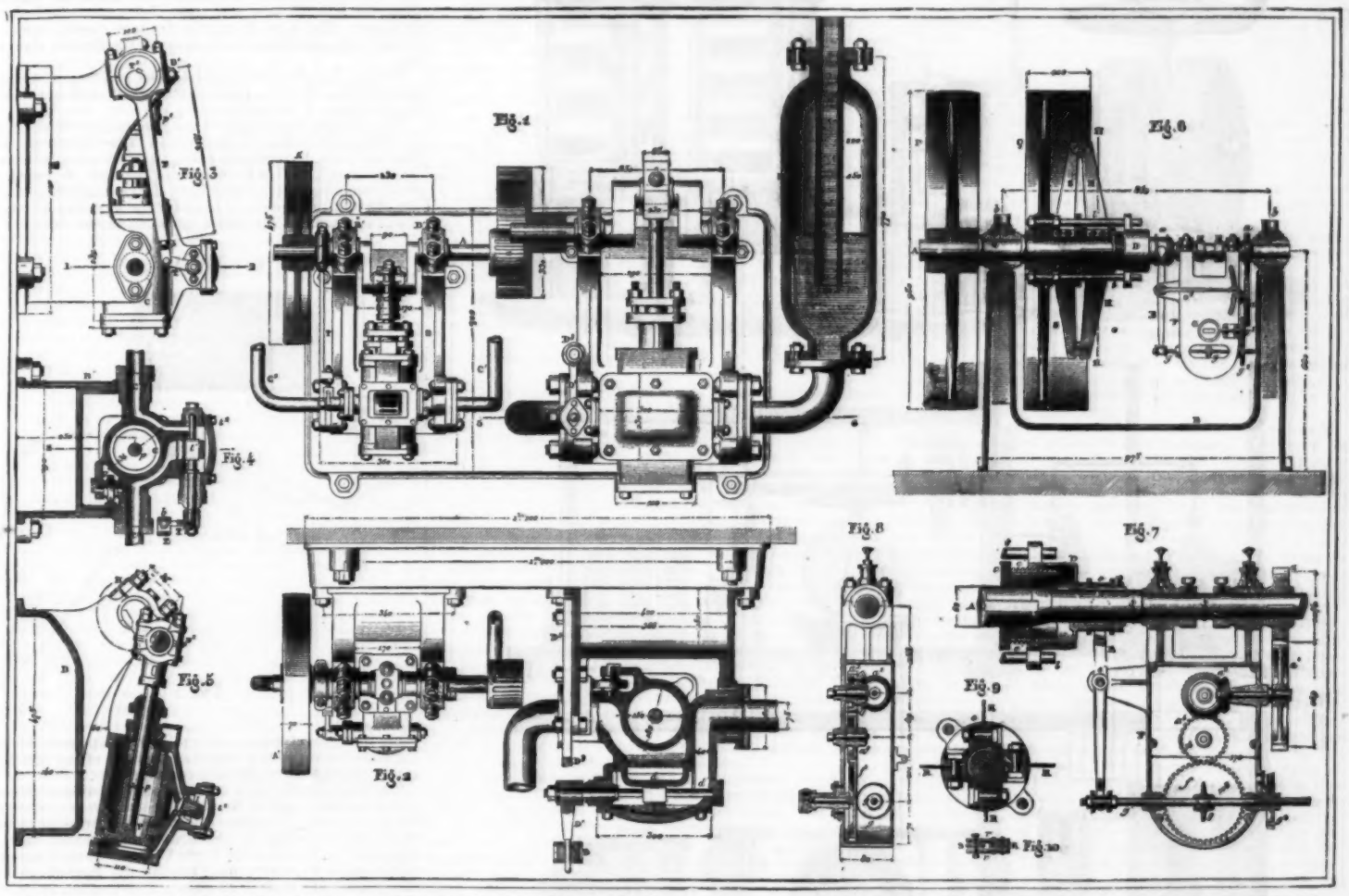
From the revolution of the shaft, A, there results, as we have said, a longitudinal displacement of the axle, g^1, and of the disk, *g*. The latter, on separating then from the center of the disk, *f*, is carried along by this disk through friction, and its velocity is registered by a counter, G, to which it transmits motion by means of the gearings, g^2 and g^3 (Fig. 6).

In order to keep the contact between the disks *g* and *f* permanent, the axle of the latter rests on a bearing which tends constantly to repel it, thanks to a spiral spring that may be seen in Fig. 8.

The velocity of the disk, *g*, goes on increasing in measure as it removes from the center of the disk, *f*, that is to say, such velocity is proportional to its longitudinal displacement, and consequently to the stress transmitted by the motor. On another hand, for the same position of this disk, the number of revolutions that it effects is proportional to that of the shaft, A. It results, then, that the velocity of the disk, *g*, is proportional to the two elements, *power* and *velocity*, of which the expression "work" consists, that is to say, it is directly proportional to the work.

To obtain in kilogrammes the work transmitted, it is only necessary to multiply the number of revolutions shown by the counter by a coefficient that may be determined by an experiment once for all. This coefficient is inscribed upon the springs.

The axle, e^1, carries an index, e^2, which moves over a divided dial. By multiplying the number shown on the latter by a previously determined coefficient inscribed on the springs, the stress is obtained in kilogrammes.—*Machines, Outils et Appareils.*



FIGS. 1 TO 5.—SMALL OSCILLATING MOTOR FOR ACTUATING A PUMP.

FIGS. 6 TO 9.—MEGY'S TOTALIZING DYNAMOMETER.

OIL MILL MACHINERY.

IN the manufacture of oils from linseed, cotton, rape, and other oleiferous seeds it was formerly the practice to pound the seed in hardwood mortars with pestles shod with iron, set in motion by cams somewhat on the principle of ore stamping mills. The triturated seed was put in bags and squeezed in press-boxes by vertical rams, which were also driven by cam mechanism. These mortars and press-boxes constitute what are known as Dutch mills; and, although both antiquated and slow going, they are still to be found in operation in a few instances both in this country and on the Continent, being by some considered preferable to the more modern hydraulic system of working. The great majority of thinking persons however, adopt appliances on the latter principle, which, it is unnecessary to state, is both theoretically and practically correct. We propose briefly to describe the modern processes connected with this industry, illustrating our remarks by machinery designed and manufactured by Messrs. E. R. and F. Turner, of St. Peter's Iron Works, Ipswich, Eng., who have given special attention to this class of apparatus.

Assuming the seed to have been properly screened, the first operation is to pass it between a pair of crushing rollers, by means of which the seeds are broken and reduced to a coarse meal. These roller mills are illustrated on the next page. The rollers are of unequal diameters, the larger being usually from two to four times the diameter of the smaller. The seed is supplied from the hopper by means of the feed-roller, to which rotation is given from the spindle of one of the crushing rollers. The quantity of feed is regulated by a valve. Under the rollers are placed steel scrapers, which are kept in contact with the rolls by weighted levers. These clear the rollers of the crushed seed, which, from its glutinous nature, would otherwise adhere to their surfaces. The pressure is given by a combination of a screw and compound wedge, acting equally upon the two bearings of the smaller roll spindle through a strong spiral spring. The second operation is that of grinding the crushed seed under a pair of heavy stone edge-runners, as shown in Fig. 2. The two edge-stones are usually about 7½ feet diameter, and they

run upon a bed-stone, which is surrounded by an iron curb. The seed is kept in the track of the stones by a sweeper, and, when sufficiently ground, the attendant, by means of the hand lever shown, lowers a second sweeper, which collects it and discharges it through an opening, the door being withdrawn for that purpose.

The third operation consists in heating the ground seed in a steam-heated kettle which comprises a cylindrical chamber, surrounded by an annular space, into which steam is admitted by a pipe, which is provided with a regulating cock. The condensed steam or water passes off from under the bottom of the kettle. A vertical shaft gives rotary motion to arms or stirrers, which keep the seed constantly agitated, causing it to absorb the heat and preventing its adherence to the heated surface of the chamber. The top of the kettle has an iron cover, with a door, through which it is charged. When sufficiently heated the door is opened, and the stirrers sweep the seed into funnels, through which it is filled into woolen bags suspended below. The seed is now ready for the concluding operation, which consists in pressing it in the hydraulic presses shown with the pumps attached in Fig. 3. The press cylinders are supplied by two force pumps, and the plunger of the larger being about six times the sectional area of the smaller, the larger pump is weighted to about 750 lb. per square inch, and the smaller to from 2 to 3 tons per square inch, giving a total pressure on the rams, which are 12" diameter, of about 300 tons. Each press is fitted with four boxes, and in each of the spaces receives one of the bags of heated seed, which has been previously placed in a horse-hair envelope. The attendant first fills one press and opens the communication between the large pump and the charged press by means of valves, which causes the ram to rise until there is a total pressure of about 40 tons exerted on the press; the safety valve of the large pump then rises. During this operation the second press is being filled with the seed bags, and the communication is then made between it and the large pump, and the ram of the press is raised in like manner, the large pump being again relieved by the safety valve and its communication with the presses closed. At the same time communication is opened through the valves between the small pump and the presses, the extreme pressure then given, of about 300 tons, allowed to remain for a few minutes, and the oil is effectually expressed. As it leaves the seed it passes through the woolen bags and horse hair mats, finding free exit at the edges, thence it runs into the channel, which passes round the upper portion of each of the boxes; a communication is made from one box to the other, so that the oil passes from the upper boxes through the lower ones and thence into a cistern, usually placed below the floor, from which it is pumped at convenient times into larger tanks for storage. The cake, after being stripped of its woolen covering, is pared at the edges and placed in a rack to cool and dry, and afterward forms the well-known oil-cake of commerce. We should observe that the presses we have been describing are of much greater power than those we have illustrated, although the principle is the same in both. Our engravings represent a pair of 12-inch presses and pumps. Each single press is fitted with boxes for making 4 cakes of about 8 lb. each, and expressing about 12 lb. of oil at each spell. The pump plungers are 2½ inches and 1 inch in diameter, and the stop valves so arranged that the full pressure is maintained on the one press while the other ram is working up. By the addition of an extra stop one set of pumps is enabled to work three presses, a system now very general in large mills.

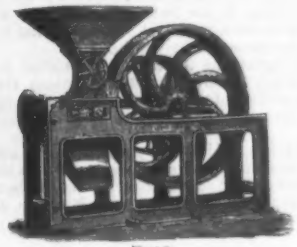


FIG. 1.

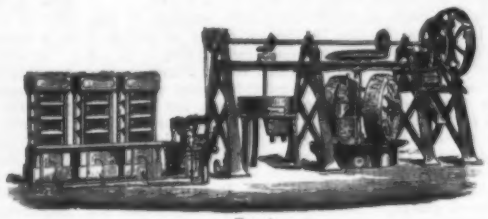


FIG. 4.

FIG. 2.

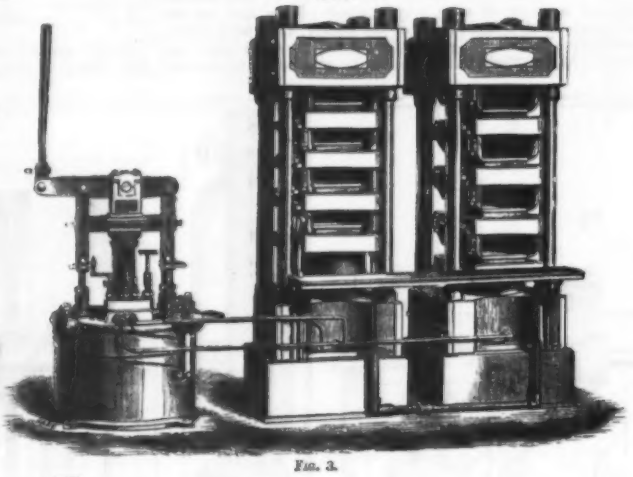


FIG. 3.

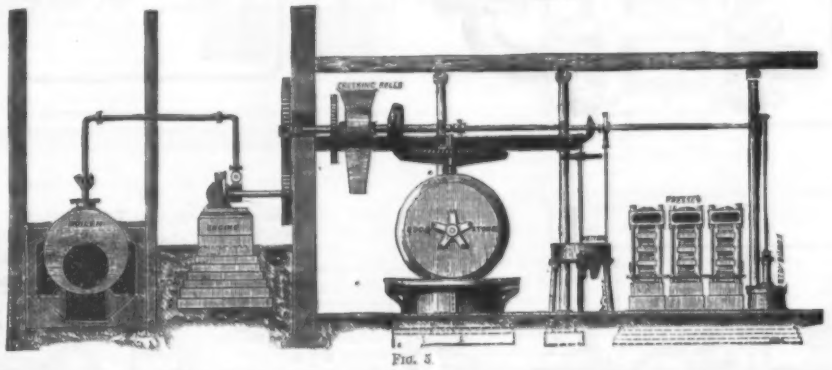


FIG. 5.

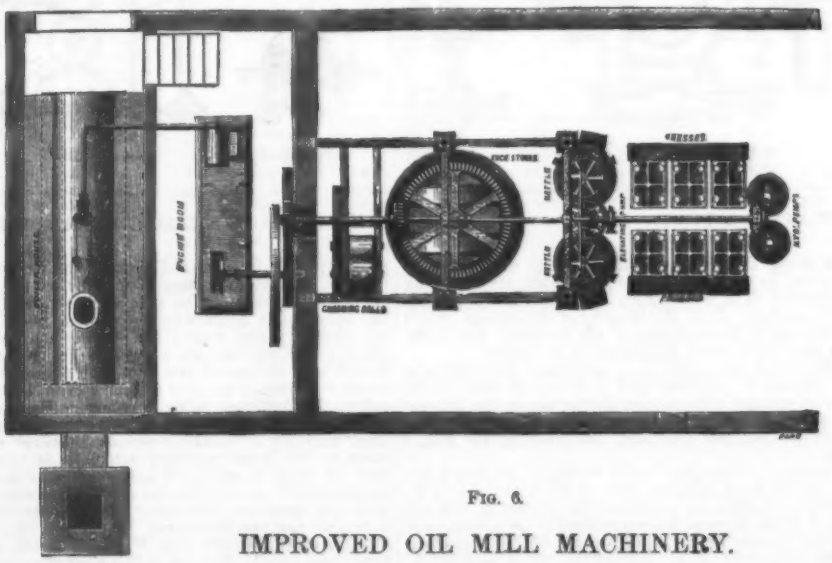


FIG. 6.

Fig. 4 represents a compact arrangement of self-contained oil-mill plant by Messrs. Turner. It is designed to work 18 qr. of seed in 24 hours, yielding about 51 cwt. of cake and 2,100 lb. of oil, comprising a set of 12-inch seed rolls, a set of 400 ft. edge-stones, a 30-inch seed kettle, three 8-inch ram hydraulic presses, with four boxes and envelopes, and 8 meal bags to each; a set of pressure pumps with treble stops, pressure gauge, pump for raising oil to storage tank, paring table, and bagging stripper. It also includes the shafting and gearing for working the machinery from the steam engine. This set is also arranged with iron framing, standing upon the ground without any connection with the building, thus especially suitable for exportation. The engine for driving this set is of 4 horse power nominal, taking steam from a 6 horse-power boiler. Figs. 5 and 6 show respectively an elevation and plan of a complete oil-mill plant of larger size, as designed and manufactured by Messrs. Turner, the various machines being specified thereon, and needing no further explanation.—*Iron.*

IMPROVED OIL MILL MACHINERY.

[CINCINNATI ARTISAN.]

RECENT BOILER EXPLOSION IN CINCINNATI.

THE cuts represent a boiler explosion which occurred at a rolling mill in Cincinnati, December 19, 1883. Fig. 1 is a perspective view of the boiler itself, showing the effect of the explosion. The boiler was a two flue horizontal boiler, and was set over a furnace, the waste gas from which was used to supply heat for making steam, as is a common practice in iron works. The boiler was about 45 inches in diameter and 25 feet long; the flues were 15 inches in diameter. The heat from the furnace passed under the boiler shell, and thence back through the flues to the chimney.

Having described the kind of boiler and way of setting it, a description of how a furnace is worked will aid in showing the cause of the accident.

The furnace man regulates the temperature of his furnace by means of a damper at the summit of the chimney. If his iron is too hot, he reduces the draught; if it is not hot enough, he increases it. This is done suddenly, and, of course, suddenly reduces the temperature of the gases passing through the flues of the boiler, or as suddenly increases it; also reduces or increases the steam pressure in the boiler. This being understood, reason enough will be apparent for making these boilers of the best material, and of the best form, and providing for all possible contingencies.

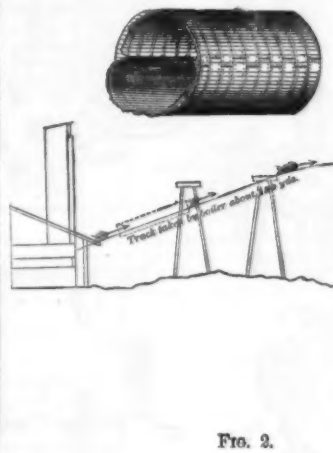


FIG. 2.

The heads should have been stiffened by at least two stays secured to them and to the shell, so that the head would not buckle or bend. The flues (the collapsing pressure of which would be about 275 lb. per square inch) should have had angle iron or T iron rings riveted around them at the center of the length to prevent their collapse, for flues of this diameter should not be worked above fifty-five lb., or one-fifth the collapsing pressure, unless properly stayed. If flues are ringed, the working pressure can be increased in proportion.

Now, as to the cause of this explosion: the head had no stays, the flues no rings, the heads bent or buckled backward and forward with every fluctuation of pressure and temperature, the front head giving way in the flange, where it had been gradually cracking for some time.

It may be asked, how would the bracing of the flues help, or would it have aided in this case? I think it would. It has been shown that the immediate cause was a want of stays for the heads, as the flues pass through the heads. If the former are not properly stayed, more strain comes on the heads. We must, in a boiler, give every part its proper work, as in a bridge, or else disaster will follow.

In this case the boiler was driven by the issuing contents about 150 yards in a direct line, and a considerable distance into the air, passing under one elevated coal railway and breaking another in two, killing two men.

Those who saw the boiler during its flight (represented in Fig. 2) say that it went on a gradual incline till about over the place where it fell, and dropped nearly straight down, being found at right angles to its position when set. This is just the action of a rocket; as long as any explosive contents remain, the rocket flies on; when they are spent, the momentum being gone, the rocket case and the stick drop down.

The explosive contents in this case were the steam, and water turning into steam, till the temperature is reduced from 312°, at 80 lb. p. s. i., to 212°, the temperature at which water boils in an open vessel. By the time this reduction would take place, little if any water would remain, which will account for no water being found around after an explosion, and the current saying, "It blew up from shortness of water." The fact is, that if a boiler is in condition to blow up, the less water it contains the better, as there will be less damage done in that case to life and property, because less explosive will be present.

ALFRED R. PAYNE.

MR. EDISON ON STORAGE BATTERIES.

THERE appears to be one point at least on which our "own Edison" and those engaged in the manufacture, storage, and distribution of gas have thoroughly agreed upon. This unanimity of opinion centers upon the idea that the so-called storage batteries, whereby electricity is to be delivered to consumers, already bottled up and ready for use—somewhat after the fashion, at present in vogue around New York city, of furnishing "bottled milk"—is a delusion and a snare, when commercially considered.

A representative of the Boston *Sunday Herald* called upon Mr. Edison, some time ago, with the object of ascertaining his views upon the electric light in general; and the outcome of the interview furnishes some very interesting reading. Mr. Edison, in considering the subject of "storage," made use of some plain language, and we reproduce some of his remarks, regretting that lack of space prevents us from giving the interview in full. In answer to the question as to what he thought of the utility and value of storage batteries, Mr. Edison said:

"The storage battery is, in my opinion, a catch-penny, a sensation, a mechanism for swindling by stocking companies. The storage battery is one of those peculiar things which appeal to the imagination, and no more perfect thing could be desired by stock swindlers than that very self-same thing. In 1879 I took up that question, and devised a system of placing storage batteries in houses connected to mains, and charging them in the day-time, to be discharged in the evening and night, to run incandescent lamps. I had the thing patented in 1879 (I forget the date of the patent), but there is nothing in it. I rang all the changes on it. My plates were prepared like Plante's. The method of preparing them for charging is more tedious, but it is better than that of Faure, after preparation. You know the first storage battery was sent from France to Sir William Thomson, who was at first astounded by it. He was asked to indorse it, consented, and took a retainer; but on investigation he became convinced that there was nothing in it, and returned the retainer to the French company. The fact is, the more he investigated the more he found out the fallacy of the whole business. On account of what Labouchere calls a swindle, this secondary battery has been used by the arc companies in England. One company alone, on the strength of an accumulator and an incandescent lamp copied from mine, by one George Lane Fox, floated subsidiary companies, whose aggregate capital was over thirty millions of dollars, and immense sums were paid by these companies to the parent company for rights. Within the last few months the bubble has burst, the shares, upon which $25 have been paid, are offered at $1, and the swindling companies have been sued for making misrepresentations in their prospectuses as to the value of the accumulator and the right in the incandescent lamp of Mr. Fox, it appearing, from the proceedings before Mr. Justice Chitty, that another company had a right to the lamp, and this company acknowledged that it was a piracy of the Edison lamp, and were paying royalty to the Edison company for the right to use. The action before Justice Chitty was brought by a stockholder in a subsidiary company to cause the return of his subscription on the above account. The judgment was in his favor. This was the great Brush electric light bubble, in which millions were lost, and caused the now celebrated article of Labouchere. One of the leading spirits in the bubble is in this country at the present time attempting to do the same, but Carlyle's saying about thirty millions of fools probably didn't apply to foreign countries.

"Scientifically the thing (storage) is all right, but commercially an absolute failure, as one can imagine. You can store it and hold it; but it is gradually lost, and will all go in time. Its efficiency, after a certain number of charges have been sustained, begins to diminish, and its capacity and efficiency both diminish after a certain time in use, necessitating an increased number of batteries to maintain a constant output. Owing to corrosion of the sustaining plates of the battery, the effect of local action and other causes, too many to enumerate, the yearly depreciation of the battery is not less than 30 per cent. of its first cost, if used daily. The facts are that there are two or three companies that have been organizing subsidiary arc light companies throughout the country for some time past. In this arrangement the parent company made money by selling machinery, etc., to the working companies, but the latter companies are not making money, and have nearly ceased giving new orders. Now the parent companies, finding the call for machinery slackening, have come in with their secondary batteries. They now make this statement, which is the cleverest thing I ever heard of: 'Here, gentlemen, you have a large investment in machinery, etc., for furnishing light, but are not making any money out of it. Now, we have something by which you can utilize your machinery. You can work day and night, and can do more work. You can utilize your present plant in the day-time, and the electricity thus made in the day-time for incandescent lighting, and in the night have your plant for arc lighting direct. That sounds good and fair, does it not?' The board of directors discuss the offer and think it a good thing. Then they conclude to go into it. You probably know what the wisdom of the average board of directors amounts to.

"I will tell you where the fallacy in this arrangement lies. It consists in the fact that the cost of batteries to store this extra electricity that could be produced in the day-time would be twice as much as the station that produced it; so that, if the company have already invested $100,000, and agree to utilize their machinery in the day-time, by the addition of storage batteries, they will find that to carry out their desires it will cost them $200,000 for the batteries. I will guarantee that not one board of directors in a hundred will see it, and the parent concern will not tell them of it until after they have purchased. It seems to be natural with boards of directors that if there be a wrong way to do a thing they will surely do it that way. Well, they have purchased the storage batteries, of course, of a cost of $200,000. On that investment, at the end of the first year, they have a depreciation of thirty per cent. To save themselves they will have to earn interest on their investment. They must earn enough to meet the extra depreciation on their plant running through the day, and will have to spend double the amount in coal to obtain the same output from batteries, for the reason that they interpose between the source of energy and the light a thing in which there is a loss both in charging and discharging, and a loss while standing, and that loss increases as the battery gets older, after a certain maximum is reached.

"The maximum of a storage battery is about fifty per cent. You get the maximum of current when you utilize the full capacity of the battery, the same as in a steam engine, where, if steam is admitted for the full stroke, 50 per cent. of the steam or power is wasted, but you obtain the maximum power from the engine; but this is also the minimum of economy. Hence, to get the proper economy, engine builders only take one-third to one-fourth of the maximum power from their engines, but this adds to the investment, which is compensated for by the saving in economy, which more than pays interest on increased investment. When they say that 90 per cent. is obtained from the battery, they tell you what is scientifically true. They say they get ten lights of 16 candles each per horse power of current. Now, that is true and untrue. If you get a horse power of current from a battery, it will give you 10 lights of 16 candles; but to get that you have to net all losses through the battery, through the wires, through the dynamo, and all that. They start off with a horse power indicated in the engine. A certain amount of this is taken to move the engine and dynamo, and a certain amount is lost in the dynamo to convert power into electricity, because no machine is perfect; a certain amount must be lost on the wire connecting the station with the secondary battery; another amount is lost in charging the battery, due to its resistance and imperfection as a mechanism; another amount is lost during the interim between charging and use; another portion will be lost in discharging the battery through the lamps, and still another amount will be lost in the wire connecting the battery to the lamp. So that your horse power will dwindle down until it will give you only about three lamps; whereas, if you worked direct, you would probably get six lamps."

[Continued from SUPPLEMENT No. 675, page 5994.]

A REVIEW OF THE DOCTRINE OF ETHER WAVES AND OF THE MATERIAL NATURE OF LIGHT.

By ELLEN R. PRESCOTT.

ACCORDING to Prof. Clerk Maxwell's theory, gaseous matter extends itself equally in all directions, as the result of equilibrium of forces, and we have seen that while a fixed ratio of pressure, density, and lateral dimensions of the aperture is maintained the law of motion is invariable, and that in obedience to this law gas under mechanical coercion breaks up or changes its molecular constitution, as in the mixture of hydrogen and air cited.

By the emission theory we have a similar action of light particles. Light emanates, radiates, or is propagated from luminous bodies in straight lines. Moreover, it emanates from them in all directions, and, as stated by Herschel, when it proceeds in empty space, or in a perfectly homogeneous medium, the movement is not only rectilinear, but also of uniform velocity. When, however, it encounters an obstacle or a different medium, it undergoes certain changes, which may be stated as follows: It is separated into several parts, which parts pursue different courses, or are otherwise modified. These modifications present, according to the different conditions of the intercepting obstacle and the axial presentation of the impinging molecule, the phenomena of reflection and absorption, of refraction, and the varying forms of inflection, or of direct transmission.

In the diffraction of light, which has been assumed to be the key to the motion of ether waves, it must be remembered, first, that the light is compound, as is shown by dispersion and the insulation of colors, that light moves at the rate of about 194,000 miles a second, and that if the elements of a compound beam bearing such projectile force be subjected to the coercion of a diffraction slit, then the motion of each individual molecule of luminous matter under this enormous pressure of moving force will depend upon its angular relation or the obliquity of contact with the resisting sides of the slit; in other words, the appearances rendered will depend solely upon the angle of incidence and consequent angle of reflection which we establish in breaking apart, by barriers, the compound beam. The width of the diffraction bands, or the diffusion of light, will bear the same relation to the linear dimensions of the aperture as has been found to exist in the escape of gases. In the one case, as in the other, the length of the mean path of the molecule is "inversely proportional to the width of the opening in the plates." Moreover, with a correspondence in the fixed ratio of dimension and pressure or in equivalent conditions the trajectory of the hydrogen atoms in escaping is coincident with the hyperbolic movement of a monochromatic beam of light.

An admirable paper by A. A. Michelson, U. S. N., shows that "if a fine adjustable slit be narrowed down very greatly, the colored diffraction fringes widen out until, when the width of the slit is reduced to less than the one-fiftieth of a millimeter, the central space only is seen, and appears a faint bluish tint. Moreover, the light so transmitted exhibits traces of polarization when seen through a Nicol prism. If the slit is still further narrowed, the depth of the tint and the amount of polarization increase until, when a width of only one one-thousandth of a millimeter is reached, the color becomes a deep violet.

Lieut. Michelson's reviewer considers the possible explanation to be that the light which comes through the slit, and is reflected at its edges, accords with the direction of the plane of polarization. But there remains, he says, the difficulty that these effects should take place with all widths of slit and vary with the nature of the material. One important point, he admits, is that a slit of this degree of fineness admits the shorter waves of light more freely than the longer ones.

The objection raised is obviously based upon the inability of ether waves to produce, through a change of mechanical relations, these varying results, while with the present view these experiments seem to bear direct and absolute testimony to the material and compound nature of light, the particles with greater amplitude of vibration being shut out by the exceeding fineness of the slit. The deep violet tint at the greatest reduction of the slit results from the extreme tenuity of the matter which first becomes manifest as light at that point of the solar spectrum where it verges upon the ultra-violet, or purely chemical rays. In the decomposition of white light by the mechanical appliance of an ordinary diffraction slit, the differences of direction which the separate colors assume, will be governed in some degree by the deflection of path of the molecules of one colored ray by another, while the repetition of the image of the slit seems to be a simple reproduction, at varying angles of incidence and reflection, as in a series of similar images formed by parallel mirrors. In decomposition by polarization all the colors are not polarized at one incident, and crystals are found to absorb the different colored rays differently, according to the planes of movement, and their relation to the axis of the crystal. Newton's theory of "fits," or the polar attraction and repulsion of atoms in molecules of light, is here analogous to the polar movement of ordinary matter.

By the undulatory theory, a spectrum is divided by dark bands because of absorption; this means simply the power of certain substances to impede wave movement—absorption—and the consequent dark bands are, therefore, the result of interference or of fractional discordance, and it is the sum of the discordant wave lengths which determines the position of the band, as the interference of two half lengths would retard a whole wave movement. But in the interference of light, we are by the undulatory theory compelled to "disregard the commencing and terminal uncompensated undulations and parts of undulations as being so few in number as to excite no impression on the retina, and to consider the interfering rays as of indefinite duration, or as destitute of either beginning or end." We are here involved in calculations and suppositions upon the loss of half waves, and the facts cannot be made to correspond in some cases, as of reflected rings (which are supposed to originate from a partial transmission of waves reflected from an inner surface), without throwing away, or allowing for the loss of fractions of waves. This has been done by reckoning the inequality as the change necessary in passing through varying strata, or upon entering a medium of different density.

The dark bands in diffraction have necessarily the same explanation of interference, with this difference, that in the case of absorption in the spectrum, the sifting out of the light, or the production of non-synchronous waves, is the result of atomic action governing the resultant movement of the molecule; while the sifting out in diffraction bands is caused by mechanical coercion.

Now, if, with Prof. Tyndall, we resolve this wave movement into its elements, we find that each distinct particle of the wave gives birth to a series of waves, or that "every point of the wave which fills the slit is itself a center of a new wave system, which is transmitted in all directions through the ether behind the slit." This is the principle of Huyghens, more recently and clearly expounded by Prof. Tyndall. If, upon the molecular theory of light, we conceive each distinct particle of the wave advancing from the first slit to the second, we visualize the movement of atoms after they have been brought into collision with the sides of the slit. The amplitude of oscillation or wave-length resulting from the collision will be determined by the sine of the angle of incidence. But, superadded to the resiliency of the matter in contact, the particles are under the enormous projectile force of 194,000 miles a second. This involves the idea of translation of particles, and not of propagation by wave movement of a medium. The particles propelled from the first slit convey a moving force compounded of molecular collision and of the enormous speed of translation, and after the beam is shivered against the sides of the slit by its own momentum, the motion of the atoms, which have emerged from this coercion, will be the sum of the motion imparted, the law of this motion being determined by the conditions of contact. The result is here shown, as in the case of refraction and polarization, to depend upon molecular grouping. Here, as in the conical refraction, the "ray is divided into an infinite number of parts," and these divisions or parts, as "the distinct particles of the wave," are luminous entities responsive to the fundamental law of polarity.

According to this view, diffraction, similarly to refraction, may be established whenever such resistance is secured by an obstacle as will give differences in the relative obliquity and speed of the impact of these luminous particles. A ray of light from any physical point or line may be broken up by the action of minute barriers. Lace, net, the fibers of feathers, or, if nature has been generous, by simply lowering the eyelids, the intercepting eyelashes will divide the compound beam into its colored elements. A bubble of air in a defective window-pane, and a distant street lamp, have given me a lively satisfaction, and many curious results, by simply varying the point of observation.

Accepting, of course, the rhythmic movement of light particles, the colors of thin films is accounted for, as in the undulatory theory, by reflection from the under surface or layer of molecules. It is not, however, a reflection of different wave lengths of ether, but of the dispersed particles of a compound beam, the dispersion being occasioned by the impeded transmission of the incident ray through the outer film, the different angles of incidence establishing the various reflections. The invariable relation of the colors to the thickness of the film, and a transference of the property of colored reflections by the fine grooving of non reflecting surfaces—as may be shown in imparting iridescent coloring to the surface of sealing-wax, by simply moulding it upon the grooved surface of pearl shell—prove that the colors are due to the mechanical state of the substance upon which the light impinges. The walls of the channels act as the opposing sides of small apertures, or as a flaw acts in crystals, by breaking continuity and establishing a resistance, and consequent reflection of the partially transmitted beam. In either theory, the law of motion would be derived from the condition of the opposing surface, for in the theory of ether waves the movement of every particle of ether is regulated by that of the molecule of the luminous body from which it takes its origin, and will be regular or irregular, periodical or not, according as that of the original molecule is so or otherwise. In the one case, it is the superposing of the motion of a luminous particle upon a secondary matter or agent; in the other, it is the direct action of the infinitely fine elastic particles themselves while subject to mechanical resistance.

The coloring of a soap bubble is explained upon the same principle of reflection from the inner surface or layer. The mechanical resistance of the outer layer breaks up the incident beam; hence, the distribution of colors will depend upon the reciprocal action of the impinging beam and the internal motion of the atoms.

The point of difference in Newton's doctrine of light and the more recent developments of modern science, is his law established for the movement of light particles upon entering a denser medium. This has been regarded as the result of a false measurement of the elasticity of attenuated matter. He simply transferred to the light matter the inertia of gross matter, applying the law of the square of distance in attraction, and adapting his formula of elastic collisions in the mass to the movement of atoms, without taking into account the changes in the elastic properties of matter when the inertia of concrete matter is converted into the elasticity of atoms. In a rigid interpretation of the laws of gravitation, he ignored the initial principle of motion, that by expansion or separation greater relative motion is imparted, and that in consolidation or aggregation of atoms relative motion is diminished. Hence, by the law of reaction, the dynamic force becomes a diminishing quantity when brought into more frequent collisions with the packed atoms of denser substances. The amount of this moving force of every such impinging molecule is necessarily altered with every collision, and a new direction given to the

molecular stream; it is, therefore, in obedience to general law that, in a ray of light, the velocity is diminished and the direction of the beam is changed by the resistance of a denser medium.

The reciprocal action between the molecules of ordinary matter and the impact of light is clearly indicated in the phenomena of fluorescence, and in all those cases of phosphorescence which are not attributable to physiological or purely chemical relations. The phosphorescence induced in the ruby or diamond by molecular discharge is not a surface effect, but is due to internal motion, being subject to and dependent upon the axis of vibration, which is shown in the quenching of the light by a Nicol prism. This internal emission of light, described by Sir John Herschel under the name of "Epipolic Dispersion," and by Sir David Brewster as "Internal Dispersion," has been experimentally treated by Prof. Stokes, whose theory of a change of refrangibility in the incident beam by the molecular action of the fluorescing substance seems equally applicable to the present view of a bending of the path of light particles upon collision with the refracting inner surfaces.

That the mysterious phenomenon of phosphorescence seems due to molecular action, gives additional weight to the theory of the material nature of light. The undulatory theory fails to account for the imprisoned lights of minerals, the glow of vegetable parasites, and the intermittent luster of light-giving animals. If, however, as is shown in experiments by M. Niépce, light is a component of the darkness in hermetically sealed tubes, becoming visible only by molecular or atomic changes set up by heat or chemical action, we may assume an analogous condition for the emission of light whenever such motion is imparted to the uncombined atoms of "radiant" or electric matter involved in organic structures. In vital processes, as in the chemical activities of decay, there is a motive power equivalent to the light-producing currents in Geissler tubes, or to the increase of temperature in M. Niépce's experiments.

If we regard force as the inherent property of the fine matter out of which the coarser matter of our physical reckoning is evolved, and that the varying phenomena of light, heat, and electricity are "modes of motion" imposed by reciprocal atomic action, we establish a condition where the phosphorescence of inferior organisms may be correlated with the activities of higher types of life, and where the chemical changes of decay jostle the disintegrated particles, thus infinitely divided, into the vibratory movement of light.

This production of light by lower orders of life, or in the higher types when vitality is greatly lowered, does not involve a sensible disintegration of animal tissue, but rather that the movement of this interstitial matter becomes visible as light when its activities are not absorbed in functional processes. The instance cited by Dr. Kane of the flickering phosphorescence upon his benumbed hand in the Arctic midnight, and other examples given by Dr. Phipson of the emission of light by patients suffering from extreme nervous prostration, seem to indicate a correlation with vital principle, as in the chemistry of decay there is a balance, so to speak, between the light and the changing conditions of dead matter.

That the principle of light is held interiorly in the substances of the eye, we are made conscious of by a sudden pressure upon the closed eyelids, or by a blow. In severing the optic nerve a vivid flash of light is experienced. The light, which is due to impact, here, as in other cases of animal phosphorescence, would seem to be the direct production of the matter involved, rather than the result of transmission by a secondary medium.

II.

Prof. Stokes' investigations of invisible rays have been limited to the ultra-violet rays of higher refrangibility, degraded into slower periods of vibration, while Prof. Tyndall, has experimented upon the invisible heat rays below the spectrum and in their elevation into a visible refrangibility; they have thus a common meeting point in the luminous or visible portion of the spectrum, where the degree of refrangibility accommodates itself to the organism of the eye. The difference between the action of radiant heat, of luminous rays, and of chemical rays has been concisely and well stated by E. H. Cook to be a difference of degree only, and not of kind: "A particle of matter vibrating four hundred billions of times a second will produce non-luminous heat; the same particle vibrating six hundred billions of times will produce light;" while weights and measures fail in our coarser reckoning for the velocity of chemical action.

The phenomena of fluorescence and phosphorescence are, as we have seen, referable to molecular action, and to the mechanical relation of the molecules of matter in a secondary condition; which condition, however, results from, or is dependent upon, the primary grouping of ultimate atoms; this primary action necessarily being purely chemical, while the secondary visible action becomes manifest in the physical effect of light. Here we touch upon that mysterious borderland which lies between purely chemical and purely physical science. Here the converging pathways of the chemist and the physicist overlap at the door of Nature's workshop, where she sorts and packs her materials, and sends her heat, light, and chemical rays out into space.

In treating of fluorescence as a mechanical effect, or a bending of the direction in which the light particles move, because of a change in the velocity of vibration, through the intro-action of the fluorescing substance, we recognize that when these highly refrangible rays impinge upon the molecules of a substance of slower vibration periods, these slower molecular vibrations react upon the impinging particles; consequently these rays, in being reflected, are hindered in their course, and thereby lowered in their refrangibility, and that in being so retarded they are brought within the range of vision. The partial or selective absorption is due, of course, to chemical or atomic action, and it is only when this chemical action produces the mechanical movement of slower vibration that the invisible rays become luminous; these rays being partially absorbed, it is only after the abstraction of the rays extinguished in this absorption that the diffusion represents the light contained in the incident beam. This partial absorption in fluorescence offers an analogous effect to the ordinary polarization of light, since experiments prove it invariable that light once passed through a fluorescing substance is no longer capable of exciting luminosity a second time in a substance of similar character placed to receive it. A body, therefore, capable of exhibiting fluorescence, fluoresces by virtue of those rays which it absorbs, and Kirchhoff's explanation of the Fraunhofer lines is equally applicable here as in the case of "every gas and every vapor which absorbs those kinds of rays which it emits when in glowing condition."

Fluorescence and phosphorescence both being phenomena of absorbed light, the inversion or dark line spectra are no less characteristic than the luminosity. Fluorescence is invariably of less refrangibility than the incident beam; this is equally true of phosphorescence, the less refrangible rays of the solar or electric spectrum quenching the light excited by the higher blue or violet rays.

Dr. Phipson's investigations show that in fluorspar, feldspar, sugar, chlorate of potash, and numerous other substances light is mechanically produced by cleavage or during crystallization; he notices that when plates of mica are torn apart, light is emitted, while one of the plates shows a positive electricity, and the other a negative electricity. Boracic acid, when heated and allowed to cool, will, during the shrinking, as it splits apart, give off a feeble light. An experiment by Prof. Pontus, in 1833, showed that a vivid spark is produced when water is made to freeze rapidly.

Besides the numerous instances of the production of light by purely structural processes in the building up of crystalline forms, there is an emission of light in the mechanical disturbances of compression and dilatation when the molecules readjust themselves, as is well known in the behavior of glass. Prof. Dana has shown that slight friction, "merely the rapid motion of a feather across some specimens of sulphuret of zinc, will elicit light." Quartz becomes luminous, but requires strong rubbing, while an odor of ozone is perceived. Otto de Guericke found the sulphur globe out of which he constructed the first electrical machine, emitted light.

We are here led to a consideration of the nature of light, not only in its mechanical manifestations, but in the chemical or ultimate relations to the matter by which it is emitted. Here exact knowledge ceases, and even analogy lends but little aid. Upon no other point of natural science have opinions differed so radically, so that the "enigma of light" stands unanswered before the investigations of nineteenth century scientists, as it did to the guesses of pagan philosophers, science, like history, repeating itself in reasoning back to the molecular philosophy of Democritus. There is, however, a convergence of testimony in the newer chemistry and physics of to-day, which points to approximately true results in linking the old theory that "all changes are due to combination and separation of molecules" to the doctrine of definite physical properties of the inferior atoms making up these molecules. Since the radiometer furnishes scales for the weighing of "sky matter," and with a disk of selenium we may catch the footfall of a sunbeam, the possibility seems opening up for investigations in mechanical relations beyond the present limit, where the science of chemistry becomes the science of physics by a manifest or physical action of matter.

In reasoning upon subsensible forms of matter, our data are the sum total of analogies, and deductions or conclusions, the result of coincidences. Strong corroborative testimony therefore seems offered when light is added to the catalogue of mechanical forces.

An eighteenth century philosopher (Bennet) has been quoted by Prof. Tyndall in an experiment where "millions of these light particles, supposing them to exist, concentrated by lenses and mirrors, have been shot against a balance suspended by a single spider's thread. This thread, though twisted eighteen thousand times, showed no tendency to untwist; there was consequently no torsion. No motion due to the impact of the particles was even in this case observed."

More recently, however, the mechanical results of a bombardment of light particles have been amply demonstrated by Prof. Graham Bell, Mr. Tainter, and others, where the adjustments are by no means so delicate as in the spider web balance—a diaphragm of selenium vibrates under the action of light. Indeed, Prof. Bell announces as the result of continued, untiring investigation, "that sonorousness under the influence of intermittent light is a property common to all matter." While Lord Rayleigh has shown that an audible sound can be produced by a vibration whose amplitude is less than a ten-millionth of a centimeter.

Now, inasmuch as this capability of light to produce this disturbance in the particles of a solid body has been (notwithstanding the opposing theory of a simple change of temperature) established, the fact that the impact of light did not affect the more exquisite balance of the spider web is due to some other cause than a mere mechanical resistance. This is, of course, to be found in the nature of the substances compared, in the susceptibility of the matter acted upon by reason of its molecular constitution. Its molecular constitution, however, is found in new chemical science to depend upon a single or multiple linking of atoms. And this difference in the nature of the substances is equally evident if, with Prof. Tyndall, we attribute the disturbance of the solid particles in a vibrating diaphragm to the more robust motion of heat or to a synchronous movement of light particles.

Dr. Werner Siemens has proved that the electrical properties of selenium are modified by the temperature at which the substance has been produced. And further, he concludes that the effect of light upon the substance is to produce a change in the molecular condition near the surface, by which it is more or less converted from an electrolytic conductor into a metallic conductor, involving a liberation of specific heat upon the surface which is exposed to the light rays. Professors Adams and Day have likewise demonstrated that an electric current is produced in crystalline selenium when suddenly exposed to light. Moreover "that a first current sent through the substances causes a more or less permanent 'set' of the molecules, in consequence of which the passage of succeeding currents is resisted."

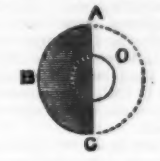
Chemical combination consists, we know, in the forming of atomic molecules, and is, therefore, directly an affair of weight, and the combining weights differ only as the atomic and molecular densities differ.

Dulong's experiments show not only that the density of a body changes with the temperature, but that the refractive index changes, and the "specific refractive power" is found to be approximately constant for different temperatures. The tables of refractive indices prepared by Dr. Gladstone, Dale, Brühl, and Dulong show a very close relationship between the atomic structure of pure chemical compounds and their transparency to light.

[*To be continued.*]

PHOTO LIGHT EQUALIZER.

COMMANDANT DE LA NOE has proposed to the Photographic Society of France a method of lighting equally the subject to be reproduced. When, for instance, an engraving or picture has to be represented, it happens that these surfaces, especially when large, receive more light on one part than another. The print in such cases presents a shaded aspect, having a rather disagreeable effect. Commandant De la Noe has succeeded in overcoming this difficulty by placing before the diaphraghm, O, situated between the two lenses of an apalantic objective, a semicircular metallic disk, A B C, the diameter of which, A C, is capable of occupying any requisite position by rotation. Half of the diaphragm is therefore hidden, but a space of about three or four centimeters intervenes between it and the semicircular disk, so that the rays of light proceeding from one of the sides of the subject may pass and reach the sensitive plate, notwithstanding the shield. By turning the disk more or less round, the lighting of the plate may be regulated, and after a prolonged trial the disk may be placed so that the most luminous side of the subject reflects less light on to the plate, the image



obtained showing an equally lighted surface. This idea is ingenious, and in many cases where it is impossible to obtain regular lighting it may be of good service.—*Photo. News.*

PHOTO-MICROGRAPHY.

By T. C. WHITE.*

I SHALL only show you the method I have employed, and if any of you like to follow my steps, you may be able to introduce many improvements, and serve to advance the art, which has many fascinating charms about it for the enlightened worker.

It has been often asked by numbers of those fossilized individuals who may be found in great abundance, "What is the good of making photographs of microscopical objects? It has been tried over and over again, and found no good; it can't be done." To such I would reply: If you found yourself knee-deep in one of those floating bogs which the sportsman and traveler may often unwittingly step upon in Ireland and elsewhere, would you attempt to run and get out of it as quickly as you could, or would you stand still to sink forever in it, because hundreds of others had tried to run, but had generally sunk to be seen no more? I reckon that you would "make tracks" to get out as well as you could; and this illustration may be used as an argument in advocating the further study of this art. It is not because our predecessors have been, as it were, floundering about in the practice of photo-micrography, that we are to rest content. But I deny entirely the assumption that they did nothing worthy of our admiration or sufficient to encourage us in our endeavors after perfection. I grant that the art is surrounded by many and great difficulties, and only the application of close study, and the concourse of many minds, can tend to its advancement; but while it is neglected or limited to a few practitioners, its advance must be slow.

I am glad to see by the photographic journals that many in the provinces and abroad are awakening to the interest attached to this process, and much good will result. I must, however, proceed to the subject of this evening's demonstration. The method most generally practiced, and recommended, is that the microscope being placed in a horizontal position, its tube should be attached by a blackened tube or a cone to the front of a photographic camera, the lens of which has been removed. Now, I find these difficulties arise. It is not every one who has got a camera, and they may not feel disposed to go to the expense of procuring one, while all the members of this club possess microscopical objectives; but further, if they have a camera, it is not an easy matter to see the fine details of a subject through the ordinary ground focusing glass. Again, unless the camera and microscope are securely fastened down to a base-board, there is a tendency to unsteadiness which is irritating in the extreme; and furthermore, this usual plan does not offer any advantages over that I wish to introduce to your notice this evening. In the apparatus before you, and which I have found so convenient, it is not necessary to have either a camera or a microscope, and is so simple that it can be adopted by the youngest member of the club; but even with this, difficulties will arise which are altogether apart from the apparatus; for instance, objects differ in their capability of transmitting the actinic rays; they may be too opaque, or brown, or they may be stained blue or red. All these conditions vary the time of exposure, only experience teaching the requisite time to imprint the image in the sensitive film just sufficiently without under or over exposure; this must be left to the cultivated judgment of the operator. Great assistance will be derived by the beginner sticking to one objective till he can produce a good result on every occasion, when a fresh one may be tried; the time of exposure being greatly varied by the magnifying power employed, the lower powers admitting of a shorter exposure as more light passes through them. The principles upon which this beautiful art is founded may be read in any of the many manuals on photography, and which are published at a cheap rate; therefore, leaving these, I will pass on to the practice. If any one needs to learn about the various apparatus employed for photo-micrography, full particulars will be found in Beales' "How to Work with the Microscope," and in Cutter's "Microscopical Technology," both of which works are in our library.

In the first place, I claim for my plan, its great simplicity, being, as you see, nothing more than a lidless box placed on its side; at the left end it has a square hole, but any aperture will do; a brass plate, having an adapter in it, slides in and out on runners for more easily changing the powers when it desired to do so. Another long aperture is made at the top side, covered by a blackened chimney to carry of the heat from the duplex paraffin lamp inside; another aperture at the bottom of the right side serves to admit the air to the lamp when the front of the box is covered up by the black focusing cloth; within the box, and attached to the left side, is a carrier working on a long and fine screw, which serves to adjust the object to the correct focus. Two condensing lenses, one to render the rays of the lamp parallel, and the other to condense them on the object, complete the arrangement so far as the box is concerned. The light passing from these through the objective emerges as a cone, and on the principle of a magic lantern projects the image on a screen to the left of the operator.

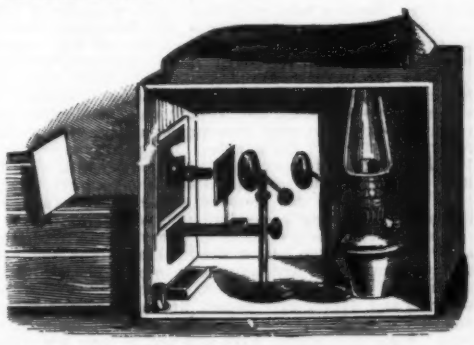
The screen consists of a heavy piece of wood having a groove formed in it, and carrying another block upon which

* Read at the Quekett Microscopical Club.

the screen is held. The screen which receives the image may be made of an oblong piece of glass either 4¼ inches by 3¼ inches, called by photographers a quarter plate, or by a plate 5 by 4, according to the amplification you intend to employ or the nature of the object may indicate, or, if lantern slides are desired, on a square 3¼ inches; these ought to have a piece of smooth writing paper gummed on that surface presented to the image. The image is then thrown on to one of these, and, the hand placed under the focusing cloth, the carrier is to be moved by means of the screw adjustment till the image of the object is sharply defined on the screen.

In many writings on this subject it is stated that the actinic and visual foci of microscopical objectives are not coincident. All I can say is, that with a ¼ of an inch, which I shall employ this evening, and with Zeiss's D, no alteration is needed from the visual focus. The screen may now be removed, and its place occupied by a dried gelatine plate, and the exposure accurately timed according to the nature of the object; but only experiments can determine this. Care must be taken before making the exposure that the light through the objective be cut off till the plate is in position, when it may be allowed to fall on the plate for the requisite time, and then cut off again before removing the plate to the developing dish; this is done, as must be evident to you all, to avoid blurring the image. I need not say that the only outside light must be a non-actinic red light, and no ray of white light must be allowed to reach the plate, or it will be "fogged;" that is, when it is developed, it will be veiled by a misty deposit in the film; therefore no actinic light is admissible till the plate is fixed.

The developer I use is the ferrous oxalate made by a saturated solution of protosulphate of iron being added to a saturated solution of neutral oxalate of potash in the proportion of one part of the iron to the three parts of the oxalate; these are best when freshly mixed. If the plate has been rightly exposed, the image begins to make its appearance in about forty seconds, and grows under the action of the developer till it is full of detail. When the image shows faintly through the film on looking at the back of the plate, I stop the development, and wash the plate by a good rinsing in rain or distilled water, and then place it in the fixing bath, which consists of a solution of four ounces of hyposulphite of soda dissolved in a pint of water; this extracts all the silver which has not been acted upon by the light. The plate must now have a great deal of washing to rid it of the hyposulphite of soda; this is thoroughly done by placing it in running water under a tap for half an hour; if the film contains a trace of hyposulphite, it causes the image to fade out after a time.



Some plates have a tendency to frill, that is, the edges of the gelatine film, while wet, have a tendency to separate from the glass and to curl up. To prevent this, the plate may be soaked for about five minutes in a saturated solution of alum, and then again well washed and stood up on a sheet of blotting paper to dry spontaneously.

Now I have thought it well, before giving you the demonstration, to tell you these details, that you may, bearing them in mind, follow the practical part with a clearer understanding of what I am doing, and why I do it, and at the same time the box and its brass contents have been getting warm, a not unimportant item in the proceedings, for if you begin your operations before this takes place, your glasses will become dewed with the moisture condensed on them, and your brass will be in a process of expansion from the heat; your image will accordingly be wanting in definition, and your plate assuredly spoiled. I will now proceed to photograph the blowfly's tongue.—*Photo. News.*

AMOUNT OF TANNIN IN THE BARK OF SOME OF THE TREES OF THE UNITED STATES.

THIS table has been prepared by Mr. S. P. Sharples, Special Agent in charge of the chemical and physical work of the Forestry Division, of the Census Office. His methods are described by him as follows:

"The tannin in each case was determined in the roesed bark; that is, bark deprived of the main part of the outside coating. The method employed was that devised by Löwenthal, which may be thus briefly described: A standard decoction of the bark is titrated with permanganate of potash, a quantity of indigo being first added to it. In a second portion the tannin is precipitated by means of gelatine, and the gallic acid in the liquid again determined by permanganate and indigo. The difference between these two readings gives the amount of tannin in the bark, the value of the permanganate having previously been determined by pure tannic acid, or by oxalic acid and calculation."

These determinations give the proportion of tannin. They do not indicate the real value of the bark of the species for tanning, which can only be obtained by actual experiments made on a large scale, other properties in the bark, besides the percentage of tannin, affecting the value of the leather prepared with it.

These determinations must therefore be regarded as approximations, says Mr. C. S. Sargent, which will serve in some cases to indicate species not now in general use for this purpose, which may be looked to as possible sources of tannin supply.

BOTANICAL NAME.	COMMON NAME.	REGION.	Percentage of Tannin.	Percentage of Ash.
Gordonia Lasianthus	Loblolly Bay, Red Bay	Southern Atlantic	13·14	2·35
Prosopis juliflora	Mesquite, Algaroba	Mexican Boundary	4·04	8·71
Rhizophora mangle	Mangrove	Gulf Coast	31·04	6·70
Exostemma Caribæum		Semi-tropical Florida	5·81	7·16
Quercus alba	White Oak	Atlantic	5·99	6·11
macrocarpa	Burr Oak, White Oak	do	4·50	8·05
Prinus	Chestnut Oak	Southern Atlantic	6·25	3·83
Muhlenbergii, old tree	Chestnut Oak, Yellow Oak	Atlantic	4·33	8·38
Muhlenbergii, young tree	do	do	10·33	6·23
virens	Live Oak	Southern Atlantic	10·46	8·89
Emoryi	Black Oak	Mexican Boundary	9·76	15·09
rubra	Red Oak	Atlantic	4·56	4·43
tinctoria	Black Oak, Quercitron Oak	do	5·90	5·73
Kelloggii	Black Oak	Pacific Coast	6·76	8·64
falcata	Spanish Oak	Southern Atlantic	8·50	4·32
nigra	Black Jack, Barren Oak	Atlantic	4·36	6·28
densiflora	Tan Bark Oak, Chestnut Oak	Pacific Coast	16·46	3·84
Castanea vulgaris, *var.* Americana	Chestnut	Atlantic	6·25	2·00
Picea nigra	Black Spruce, Red Spruce	Northern Atlantic	7·20	2·84
Engelmanni		Interior Pacific	20·56	2·75
Engelmanni		do	do	17·01	2·32
Engelmanni		do	do	12·60	0·75
Tsuga Canadensis	Hemlock	Northern Atlantic	13·11	1·31
Mertensiana	do	Northern Pacific	14·42	1·44
Mertensianna	do	do	do	15·87	1·49
Pattoniana	do	do	do	15·72	2·48
Pseudotsuga Douglasii	Red Fir, Yellow Fir	Pacific	13·79	1·56

THE FIRE RISKS OF MALTING, FERMENTATION, SIZING, AND DYEING.

THE arts or phenomena here to be considered are very far reaching in their effects and results, and either comprehend or are connected with numerous manufacturing processes and arrangements. A series of malt floors in or adjoining a brewery, a sizing place in or near factories and dye houses, and the last named as close adjuncts to mills, mean percentages of fire destruction according to conditions. There is analogy in causation among the four subjects, and in each case, in some way—either by natural incidental result, negligent handling, ignorant or fraudulent application—heat can be evolved. By considering them as grouped, a clearer view may be attained, showing that there may easily be overlooked danger among places not rated as specially fire hazardous.

Malting is here treated as practiced in the United States, where it is generally done in detached brick buildings of five to seven low stories (though the malt floors are often within main buildings of breweries); it is not, as frequently as in Europe, a process carried on in subterranean rooms, with vaulted ceilings, or in buildings having few stories, and of fire-resistant construction. In continental Europe, and especially in Great Britain, malting is much more a separate business from brewing than in the United States. In the latter the large brewers have not great confidence in obtaining always from other parties the best descriptions of malt, and, besides, there is in the United States more desire to save most of the profit on the process. It should also be stated that most of the drying floors are composed of perforated sheet metal laid on slats and joists, and the few windows are only large enough to allow sufficient access of air to the germinating grain.

Barley, which is most used for malt, must be first very carefully cleaned and dusted; otherwise, organic particles and germs of bacteria adhering to the berry would produce a kind of fermentation not wanted in the macerating process, and might ruin or greatly injure the liquors. Here then is the first danger attendant upon malting—dust and decomposition. The cleaning machines are similar to some of those used in flouring mills, but the motion of the body of the machine is generally slower, and therefore safer in this respect. The most approved kind, we believe, is a rather slow turning Archimedean screw, within a circular casing, and inclined at an angle of about thirty degrees. Extending along the whole length, and on top of this screw, a rapidly revolving brush, having long, stiff bristles, impinges on the berries as they are gradually delivered from a hopper at the upper end, lowered down, turned over, and partially separated through three sizes of wire meshes. It is evident that the carrying off and the proper disposal of the dust is a problem of much interest to maltsters and brewers. Sorting machines of various types are also used, which, while doing their special duty, complete the dusting, and need due ventilation.

The next process is steeping the grain in water, in large vats, agitating the mass thoroughly, and then either letting off the water frequently, or allowing it to enter from below under pressure, and flow continuously from the top. Moisture of a low degree aids the ignition of vegetable carbon, while of higher degree it averts ignition. This application and removal of water, while giving the moisture needed for germination, carries off weed seeds, spores, and some dust not removed in the dry cleansing and sorting. The temperature of the water is important, because the warmer the more there is absorbed of it by the grain; and this loading is sometimes practiced by short-sighted maltsters and brewers, though, if thereby weight is gained, considerable germinating power is lost. But underwriters have no cause to complain thereat. Barley steeped in water at 37° F. will absorb 28 per cent. of the liquid, which is enough, while at 68° F. the absorption will be 39 per cent. During three of his experiments, Haberlandt* found that, of perfect grain, fully capable of germination, only 80 per cent. germinated after being steeped in water at 37·4° F. for twenty-four hours; scarcely 60 per cent. was the proportion for the same time in water of 68° F., while only 15 per cent. germinated after steeping in water of 86° F. for ten hours; none at all from water at a temperature of 122° F.

In the hazardous "cold sweat" process, as it is termed, the barley may remain eight to fourteen days on the floors, and four to seven days in the "warm sweat" process. In the latter the temperature ranges from 37° to 100° F., so that frequently the layers of malt become smoking hot. Modes of shoveling, turning, and piling the malt may have serious consequences. Besides impairing germination, as already intimated, *mildew* may be caused, occasioning, with loss of weight in the malt, much more dust from the fungus spores during the dusting and malt grinding process; in short, making a more ignitible condition. The steeping occupies twenty-four to thirty-six hours, and if the proper quantity of air is furnished, full germination should take place in seventy-two hours in a temperature of 61° F.; but only about 92 per cent. production will be realized from a heat of 77° F. Steeping is, however, an oxidation.†

Neglected moist malt, with deficient ventilation, effects a contrary reaction, turns a brownish color, and shows incipient carbonization. It may be also that neglected heaps of malt will be allowed to heat in obscure corners, or over broken portions of sheet metal floors, thus endangering the wooden joists and slat supports. If malt be properly watched, this, like some other disadvantages, should never occur; but there is in this business the difficulty of night work, when duty and superintendence are rarely so well performed as in daylight. It will probably be noticed that the hazard just indicated is very similar to the cause which has destroyed many barns, ricks, and farm buildings, *i. e.*, the heating of damp hay after storage, through its carbon absorbing oxygen from the water and air; also the occasional burning of forcing houses for plants, by the ignition of wooden trays from hot beds of horse manure. Fire risk in the malting building is thus shown to be threatening continually.

The kiln drying of the malt, the best known process, is deemed needful, because after it the malt can be better preserved until used, and more economically ground, while yielding more of the tart, aromatic taste desired in beer and ale. The drying could be done by exposure to ordinary air, but it would require much more time and space, and experience has shown that in such case the tissue of the malt remains more open and liable to the disadvantage of absorbing more moisture while being kept for use. What are called "air kilns" are much used for this drying. The fuel is consumed in large stoves—themselves a considerable danger—and the hot air and smoke conducted by pipes beneath the drying hurdles, arranged in two or more stories, upon which rest perforated sheet metal or pressed woven wire floors, supporting the malt; and the temperature ranges from 122° to 167° F.—the higher it is, the better is the malt when finished. This plan is almost identical with the drying houses for cotton and woolen mills and dye houses, which portion of those establishments has caused numerous fires—in some instances even when the floors and joists were of iron. Frequently, in malt kilns, there is an iron chimney from the furnace or stoves, running up through the tiers of hurdles—certainly economizing heat, but adding much to the risk.

To save more time and some of the danger, there have been very elaborate continuous (automatic) kilns for malt drying invented and put in use in Europe, especially in Germany and Bohemia. They are so expensive, however, that the old plan is still the one most used, and we believe the automatic kilns are not, as yet, largely adopted in the United States.

The *germs* of malt constitute 2½ to 3½ per cent. of the whole weight, and if not separated give a bitter taste to the liquors brewed. Malt is, therefore, before being crushed or ground, submitted to a dusting process for this special reason, which, along with the grinding—both processes being, for convenience, generally done in the main building—forms what may be considered as the greatest risk to the brewery itself. There are various types of these cleaning and "polishing" machines, and all require for safety as careful removal of the dust as from cleaning machines for the grain before malting. Many breweries have suffered from explosions and fires caused by the dust of this process.‡ Additional risk is often caused from dusting and crushing the malt while *yet warm* from the kiln, because then the bitter germs are drier and more easily separated. In many Vienna breweries the malt is cleaned a *second time* just before being used. As German brewing processes are gradually coming more into vogue, it may not be long before this second cleaning, with its additional dust, will be common in breweries of the United States.

There is an additional risk, more particularly to the brewery, but coming through the malting process, that through imperfection in the malt causing a succession of mishaps to the brewed liquors, the mind and conscience of the brewer might become so warped as to occasion incendiarism by the proprietor. Still, it must be conceded that in no industry or trade is the moral hazard at a lower degree than with the brewer.

Fermentation plays an extensive part in the economy of nature and in the arts. The juices of fruits, roots, and cane may remain for months without change, if the cells continue unbroken, and the whole tightly covered by the outer skin: but if the juice be expressed, a chemical change begins in a few hours, or even less time—oxygen is absorbed, the tem-

* *Wiener landw. Zeitung*, 1876, No. 6.

† De Saussure states that grain in germinating absorbs about *ten times its weight* of oxygen.

‡ To give an idea of the explosive danger from finely comminuted particles of starch, dextrine, cellulose, and sugar contained in dry malt, we append the following table from Lermer. Of course the first named three constituents were in the barley before malting, and would have been equally dangerous if the grain, well dried, had been ground.

ONE HUNDRED PARTS BY WEIGHT OF DRY BARLEY

	Contain	Produce when malted
Starch	63·43	48·26
Dextrine	6·62	6·66
Cellulose	7·10	7·31
Sugar	...	2·05
Protein substances	16·25	15·99
Fat oil	2·08	2·50
Other constituents	1·11	2·16
Ash	2·40	2·10
	100·00	88·01

perature of the liquid (or the substance moistened with the liquid) rises, and the liquid becomes turbid with the motion of innumerable vibrions or particles. If the proper kind of fermentation is obtained, the turbidity ceases after the lapse of some days or weeks, there is a heavy deposit of salts, the liquid cools, and a percentage of alcohol, more or less, is found present. Though fermentation occurs in many other substances than liquids, it is proper to speak somewhat of the latter in connection with what has already been said, and also to remark that liquids prone to ferment may have that tendency neutralized by boiling; also, that sulphuric and hydrochloric acids stimulate, and salicylic acid stops fermentation.

The principal fermentations, though there is still doubt and controversy respecting them, may be classed as: 1, saccharine; 2, alcoholic or vinous; 3, lactic; 4, butyric; 5, acetic; 6, mucous or viscous; 7, putrefactive. The first is so closely connected with malting that its effects have been anticipated under that head. The alcoholic is always more or less developed in wine and beer making; but it is the third, fourth, fifth, and sixth which so often occasion "diseases" to beer and ale. In viewing the fire risk of fermentation, however, we must consider the putrefactive form as the chief cause of danger. When a substance is decomposing or fermenting, there is always moisture present in it, or obtainable by it from the air, and a slow combustion ensues, as in the rotting of wood, the decaying of dead bodies, eggs, or the spontaneous ignition of waste, rags, etc., dampened with water or oil, or with both. In fact, if we consider these, and also the oxidation of metals, digestion in animals, and some other chemical changes, we shall see a marked connection between fermentation and combustion.

In all these instances heat is evolved; and spontaneous ignition is a well known source of danger both on land and sea. The principal evidences of this are seen in the ignition of oily waste, damp hay, and substances having strong chemical attraction for oxygen, as soft bituminous coal containing iron pyrites. In some instances of putrefactive fermentation very offensive gases are evolved, such as sulphureted, phosphoreted, and carbureted hydrogen; and under circumstances favorable thereto, these ignite and even explode.

Pasteur, who considers the putrefaction of animal substances as a fermentation caused by animal organisms of the genus *vibrio*, deems that in all kinds of it, fermentation is always accompanied by an incessant change of molecules between the fermenting substance and the "living" cells which develop within it. Liebig compares the action of fermentation to that of heat, by which atomic constituents are torn apart, and caused to reform under other conditions. He also thinks that substances which, like emulsine [vegetable albumen of almonds], contain sulphur and nitrogen, by the changed arrangement of their atoms induce change in the molecules of other adjacent substances, so that they separate into new products; just as [probably] the sulphureted and nitrogenous constituents of yeast act upon sugar, starch, etc., in the formation of beer and ale.

Hallier thinks that the forms which induce putrefaction, fermentation, and mildew are all varieties of one another. He also considers alcoholic and putrefactive fermentations as both due to the influence of a single agent—transfer from place to place in the air of living molecules, which increase and grow wherever they find a suitable soil. It is a curious fact, as shown by Bechamp, that chalk is capable of establishing alcoholic, lactic, and butyric fermentations. He affirms that chalk contains living organisms of extreme minuteness, which he regards as the most powerful ferments known; and he adduces some striking experiments in proof of this theory. When we consider the varied uses of chalk, and how, in the arts, it can be continually in juxtaposition with starch, water, and creosote, which substances were used in such trials, it would be well to be careful of chalk, especially when in powder, as possibly containing a danger not yet sufficiently studied. The fact, however, that brewers have found that yeast does not work properly unless before being added to the fermenting vat it be kept in a warm place until incipient putrefaction occurs, supports the opinion that something more than the presence of organic germs is necessary to induce fermentation, such as *protein compounds* in a certain state of change.

Of all theories which have been advanced to explain fermentation, the old physical contagion theory, originated by Stahl, and reaffirmed by Liebig in 1839, seems one of the most worthy of acceptance. It attributes fermentation to the "mechanical action of certain nitrogenous matters, which are themselves in a state of decomposition, which action is imparted to the sugar [for instance] as soon as it comes in contact with the decomposing elements under favorable circumstances. The more changeable body, by its own inherent instability, initiates molecular movements in a more permanent compound. . . . The access of air is supposed to be necessary only to initiate, by oxidation, the activity of the ferment."

The question of fire risk in sizing is comparatively new, and, like some other subjects, has been forced on the attention of underwriters by the exigencies and changes of the manufacturing business. Originally the size was a simple paste of sour flour and water, with a little alum and tallow added, and put upon cotton warps to prevent the friction of the beddles from wearing away the threads in the process of weaving, and making numerous unsightly little knots in the cloth. Afterward it was adapted, with the addition of China clay and much more tallow, to stiffen calico shirtings, ginghams, and plaids. Now the practice has attained such enormous development that thousands of tons of size are annually used in England alone, and frequently a very excessive quantity is put on the cloth—even doubling its weight. There is much of this weighting already practiced in the United States, and it is likely to increase, for reasons which will appear as we proceed. Sizing is always fermented, which aids its usefulness; and the array of materials now used in it is surprising to one uninitiated. Some of these have, in themselves, considerable fire danger, and, along with this, the possibility of mildew, an excess of loading with size, and the dust from innumerable cotton sized threads while weaving, constitute the fire risk of sizing.

Sizing mixtures for cotton now contain the following materials:

1. For adhesive properties: Wheaten flours, sago, Indian corn starch, farina, rice, dextrine,* or British gum.

2. For giving weight and body: China clay, sulphate of baryta, sulphate of lime, sulphate of magnesia, sulphate of soda, silicate of magnesia, silicate of soda.

3. For softening yarns and cloth: Tallow, palm oil, cocoanut oil, castor oil, olive and other oils, paraffine wax, beeswax composition.

4. Additional for softening and body: Chloride of magnesium, chloride of calcium, glycerine, soap, grape sugar.

5. For preserving sizing from mildew: Chloride of zinc, carbolic acid, cresylic acid, salts of arsenic, etc.

Here we see greasy and oily materials, such, especially, as tallow, which are melted in separate vessels, and can easily boil over and become ignited from the furnace, as has often happened, endangering an entire mill, perhaps, as the sizing department is often located in the main basements. There is also danger that portions of sizing, swabbed up with waste, may be allowed carelessly to lie in obscure places until spontaneously ignited, which would undoubtedly occur in case of such neglect; and there must be danger to the cloth (if heavily sized and becoming wet) from the sulphate of lime and greasy matter in the size.

Another more constant fire risk is the ordinary, and sometimes excessive, use of sizing on cotton warps, occasioning—through the abrasion and jerking of numerous beddles among hundreds, perhaps a thousand looms, in one large room—a dense atmosphere of dust. Probably one reason why explosions are not yet recorded in England from this cause is the great height of weaving sheds there, and the ventilators in them. Such dust, aided by the festoons and deposits it makes, would, at any rate, most rapidly spread fire; and if mildew existed in the warp sizing, the spores thereof would add untold millions of particles to the other dust. It is noticeable that fires in such establishments are spreading more rapidly. These dangers are even greater in cotton-weaving rooms of the United States, because such rooms are generally smaller, with lower ceilings, and more crowded than in England; but it should also be stated that the plan of English ground-floor weaving sheds is coming into use here among the larger mills.

As Prof. W. Thompson, in his paper on the Sizing of Cotton Goods, read before the Society of Arts, England, argues boldly and at much length, that there is no moral wrong in making the most heavily sized cotton cloths, because the dealers and the Hindoo and Chinese buyers "prefer" them, there is not much doubt that he will find many disciples in the United States pleading the necessity of competition in coming foreign markets. Without discussing this, we would simply point out, that if the old and new markets of the Eastern hemisphere are to be supplied with cotton goods such as the Professor advocates, the fire risk on land and sea will be largely increased. It may be set down as a certainty, that in the near future there is to be a grand struggle between the United States and Europe for ascendency in these new openings for trade. To illustrate what may attend heavily sized cotton goods in their improper packing, we cite as follows from the able paper named:

"Care in packing is necessary to prevent, as far as possible, the admission of moist air or moisture to the goods, and thus to keep them dry, because nearly all gray cloth goods contain a larger or smaller proportion of size, or flour mixture; and a small amount of moisture settling on the goods, especially in warm climates, would generally result in forming the size into a proper pabulum for mildew; . . . so that, in some cases, they [it] may entirely destroy all the cloth in the bale, making it as rotten as tinder. The action of these fungi are twofold: they grow with enormous rapidity, sending out microscopic filaments much more numerous than the cotton itself in all directions, which penetrate first upon the size, and then upon the cotton itself, converting it slowly, but surely, into carbonic acid and water, the same effects which are produced when the cloth is burned." This might be considered as like iron rusting, a slow and harmless burning, but given certain conditions of oxidation flame will follow. The rusting iron and rotting cotton together would be excellent, fire-wise.

As the Professor did not consider the goods he mentions as too much loaded with sizing, it is evident that overloading must hasten and increase the danger. It is a fact well known to underwriters, that wood long heated by steam pipes, or otherwise, becomes like tinder, or largely reduced from the higher igniting point of solid wood, and ready to burst into flame and burn rapidly on the slightest provocation; and this is the fact in regard to goods such as just mentioned, in which there is continuous charring.

There are, in paper manufacture, other combustible materials used in the sizing, either in the paper pulp or after the paper is finished, which, in process, are an addition to the risk, and affect the storage risk. Common and ordinary printing papers are unsized, but the better kinds, and all writing papers, are sized, and in some instances they are very heavily weighted in the process, and often highly glazed. As recently as forty years ago all the hand made writing paper was sized simply with animal gelatine, and up to about the year 1865 a favorite size for paper was composed of about one part caustic soda to four of resin, with about 5 per cent. of the whole of alum: the last a fire resistant.* Now the list of materials used for this purpose is as follows: Resin, caustic soda, soda ash, or crystallized carbonate of soda, alum, china clay, sugar of lead, starch, glue, tallow, white beeswax, gum tragacanth, gelatine.

Although all, or nearly all, of these are used in the various sizings of large paper mills, it is proper to state that only resin and soda ash are really necessary; the others, such as clay and starch, are for filling and weight, and alum, tallow, beeswax, etc., added as improvements, or to aid the process of making size. About 5 per cent. of alum, a fire resistant, is a great improvement, if any coloring be used; a moderate quantity of tallow and beeswax prevents frothing, etc., in boiling. Sizings, their proportions and modes of preparation, vary in almost every paper mill; but generally a very concentrated solution of soda ash is first heated in an iron boiling vat, the latter surrounded by a steam jacket, and about four times as much powdered resin added, while the mixture is constantly stirred and boiled for two to four hours. Other ingredients used are added as the boiling progresses; and the latter is usually done by means of live steam, though in some smaller mills, where it is not convenient to use steam, a furnace fire under the caldron is adopted.

The greatest risk of the process is the frothing and accidental boiling over of an inflammable mixture, and its becoming in some way ignited. Where a fire is used underneath, such overflowing is almost sure to be followed by a flaming of the whole of the ingredients; and in any event, such boiling over is a danger both for the size and other surrounding materials. One of the recent authorities on paper making says: "It has been found by some of our experienced paper makers that the most effective size is obtained, if the resin is dissolved in a solution of soda ash of such concentration that its specific gravity is greater than that of the resin soap. In that case the soda solution remains on the bottom, while the resin soap floats on it, and the soap never boils over while it is being prepared, as it does with diluted solutions."

The mere presence in a paper mill of resin in bulk and powdered, tallow and beeswax in barrels, with starch, the last giving forth the unfailing and dangerous dust, must be a heavy addition to the risk, even if the process of size making be always successful. There is, however, the great danger from the grinding of the resin, which is generally done by an upright, horizontal stone, on a cast iron bed, though sometimes conical upright iron mills are used; and the tendency of these to heat is well known.

In storage, sized paper heats spontaneously to a greater degree than the unsized, but the latter is inflammable to a higher degree. Paper decreases in fire liability as the ratio of weight to bulk increases, other conditions being relatively equal.

Dyeing, in all its processes, was in former years much more simple and of less risk than at present—fuller time was given to cleaning and coloring, many of the colors being more durable than they average now; and drying was better attended to. American and English dyers, as a class, still understand little of chemistry, often not appreciating the risks they run to themselves and the goods by the use of newer substances, and the abuse of those well known. An illustration of this is the explosive nature of the various picrates, several of which are used in dyeing—mostly for yellow. As a mordant, there is used pyroligneous acid (red liquor) mixed with nitric acid and ammonia. Salts of potash, the dangerous chemical qualities of which are well known, are used in cleansing and coloring; among them the noted chlorate is employed, with various decoctions of woods, to obtain rapid oxidation. Chloric acid, potassium, carbon, oxygen—"sufficient unto the day is the evil thereof."

Sulphuric and nitric acids are very largely used, alone and combined with iron, tin, and other metals, as mordants; and if too much of such mordants be used, and not thoroughly washed out from the wool, yarn, or pieces, the finished goods will be deteriorated, or even ignited. We believe that this was the reason of the ignition on shipboard of a case of crimson woolen stockings recently imported into this country. Red is a color requiring a large quantity of acid—so much so, that the harshness and brittleness thereby imparted to the wool and the yarn are but too well known to carders. In regard to the red color in the dyeing process, a curious fact has just been noticed, which shows increased fire jeopardy as yet but little known. During the coloring of cotton pieces a madder red, using acetate of alumina, and running the goods at great pressure through heavy squeezing rollers, and then, for five minutes, through a room heated to 160° F., the goods became heavily surcharged with electricity. The hand being suddenly drawn along a piece, a complete shower of fire was observed, accompanied by a crackling noise, and giving a sharp prickling sensation.

Instances could be given here of piles of damp dyed wool allowed to remain too long unaired taking fire in and near the dye house. The dry house is an inseparable adjunct to dyeing, and a very dangerous one. In some cases imperfect scouring and dyeing have caused fire in the drying rooms, and they burning, have destroyed the adjacent main buildings. Some dye houses have attached to them a singeing department, where the piece goods are passed over red hot cylindrical copper bars, or very rapidly through the flames of gas. In general there is not much risk from direct application of fire in dye houses, as steam is chiefly used for boiling vats and for drying rolls, but in some smaller places and in some silk dye houses sheet-copper vats are used, and are heated by wood or coal in furnaces, each under the bottom of a vat. This is, of course, a considerable addition to the risk. We will mention briefly, in closing, the danger of ignition of black skein silk and silk goods, which have been heavily weighted in dyeing. Instances have occurred frequently in storehouses in the most valuable parts of New York city, on board of large steamers from Europe, and on wharves in New York and Philadelphia, which were crowded with goods. Some remarkable escapes have been made from fire through this cause, but considerable fires have also resulted.

The weight of silks of various colors can be increased in dyeing from 10 to 40 per cent. without danger, so far as is known; but *black* will take so much weighting, and the temptation is so great, that frequently this color is increased by loading 150 to 200 per cent. Such silks are rather rough, attract dust easily, and, if heated to 230° F., fall to pieces. The volume is at the same time increased, and the fibers, as seen by the microscope, are much swollen.

In regard to dyeing, the remark is proper, and it will apply to the three other departments already discussed, and to many other arts, that the fire risk in them all would be largely diminished if we had in the United States more, and more thorough, polytechnic and industrial schools, to teach chemical and mechanical knowledge to young men, and thus bring forward a class of more intelligent experts in all industries. As incentive to all striving with honorable ambition for eminence, we would say that former so-called "learned" professions are falling behind in the intellectual race, and that the scientific mechanic will be the great man of the future.—*Amer. Exch. and Review.*

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* The quantity of this rather dangerous substance, which changes to sugar with remarkable facility, may easily be increased from the flour and sago and starch. "Moist starch flour, containing 10 to 20 per cent. water, will, in a closed vessel, under the simultaneous influence of steam and increased pressure, change readily, at a temperature of 230° F., into *dextrine*."—*Julius Frankel, Proc. Treat on Starch, Glucose, Starch Sugar, and Dextrine. Philadelphia*, 1891, *p.* 36.

* Alum, a sulphate of alumina and potash, derives its incombustible character from the alumina, and in association may become an ignitive. One of the pyrophori, or spontaneously ignitible powders, is made by an intimate mixture of alum and sugar, the two being first dried, then charred in an open pan, and afterward heated to redness in a closed vessel; something of the inflammable conditions of sulphide of potassium is thereby produced.

THE MEDICAL USES OF MUSIC.

By GEORGE L. BEARDSLEY, A.M., M.D., of Birmingham, Conn.

THE spells of music have always been themes for speculation. The earliest inquiries concerned this loan of Apollo to man. Melody was no sooner revered than its birth was deciphered, and among the primitive calculations was the mission of song. Its winsome appeal to passion; its faculty of lulling heartache, scattering the vapors of a burdened spleen, or smoothing the rugged pathway of grievous duty; its aid to genius; its friendship to humor; its inspiration to holy offerings—these varied values of melody touched the harpstrings of the early student and made him sing of music as of some far off welkin descended, the offspring of the rustling river-reeds, or the whispers from well-disposed Olympus.

Its startling energy in animating, and curious ascendency over morbid experiences, suggested its utility long ago as a cure for pain, equally as a method of worship or an overture for assistance.

Pythagoras, who referred the origin of melody to the gambols of the spheres, prescribed sonnets to those laboring under aberration of mind, whether sensible or feigned. His trials of it were confined to those who were fretted by delusions. Sacred writ instances the power of sweet strains to break vials of wrath, as in the case of Saul incensed against David, who exhibited a species of mania, or madness fed by jealousy, which condition is, according to the present reading of the mind diseased, a variety of true derangement. It is affirmed of the wise Thales that under his auspices an imminent plague was banished from Sparta by the skillful exercise of musical instruments. The probability of such an antidotal element in minstrelsy lacks warrant in the light of the current views on the genesis of disease, but the notice of the story sustains the statement that the ancients expected a virtue in music to operate against the disorders of nature.

Capella, who flourished in the fifth century and wrote a quaint compound of allegory and the liberal sciences, relates the prescription of music to cure fevers and tells of its positive success. Hearing is reported by Asclepiades to have been restored by stimulating the organism with frequent blowing of a trumpet. The same practice of playing the lyre and singing lays before mad patients (apparently first suggested by Pythagoras) was continued by Xenocrates, who figured among the Greeks in 396 B. C. The confidence in the serviceableness of music in disease does not appear to have waned as successive experiments measured its utility—the indications for the remedy rather increased, for in the writings of the popular Greek schoolmaster Theophrastus, cases are detailed of the cure, by music, of rabies and the shock or depression induced by the bites of vipers or venomous serpents. Not all these reports are to be received as the sportive wiles of some deft juggler—they are far from the impossible. The terror of wounds inflicted by rabid animals and that black despair so proverbial a symptom among those thus bitten are remediless save by exorcising or some sort of machination of electro-biology that shall charm away the bugbear. Reason's discourses to a hydrophobic patient are not sovereign, and the use of sounds in silvery cadence may be a remedy yet to be appraised as prolific of comfort as the amulet or the royal touch.

In the second century Aulus Gellius, a Roman grammarian, and author of the "Attic Nights," described a case of sciatica cured by harmonics. In the later medical literature the employment of incantations to ease pain and pacify the Furies is often noted, and the measure is recommended with emphasis not repulsive. In the time of Luther the people were profoundly impressed with the special antagonism of mellow airs to the wiles of maleficent beings. This zealous propagandist of a new confession defined music as a "bitter enemy of Satan." The persuasion that mellifluous sonatas are not congenial to the devil, and that insanity in all its varieties, for ages expounded as the curse of an angry god, can be appeased by the richest euphony, is not discredited, nor lightly esteemed among those who determine law to disease.

The use of music, now preferred in insane asylums, is an evidence that we are possessed of a clearer ken of the maniac's disturbance. This is an era in which the sentinels of science are gaining ground surely—when heathen frauds are being buried at wisdom's gate, and ere long it may be affirmed of the pioneers in the healing of the mind diseased that in the "golden tongue" they have found a sway over grim despair.

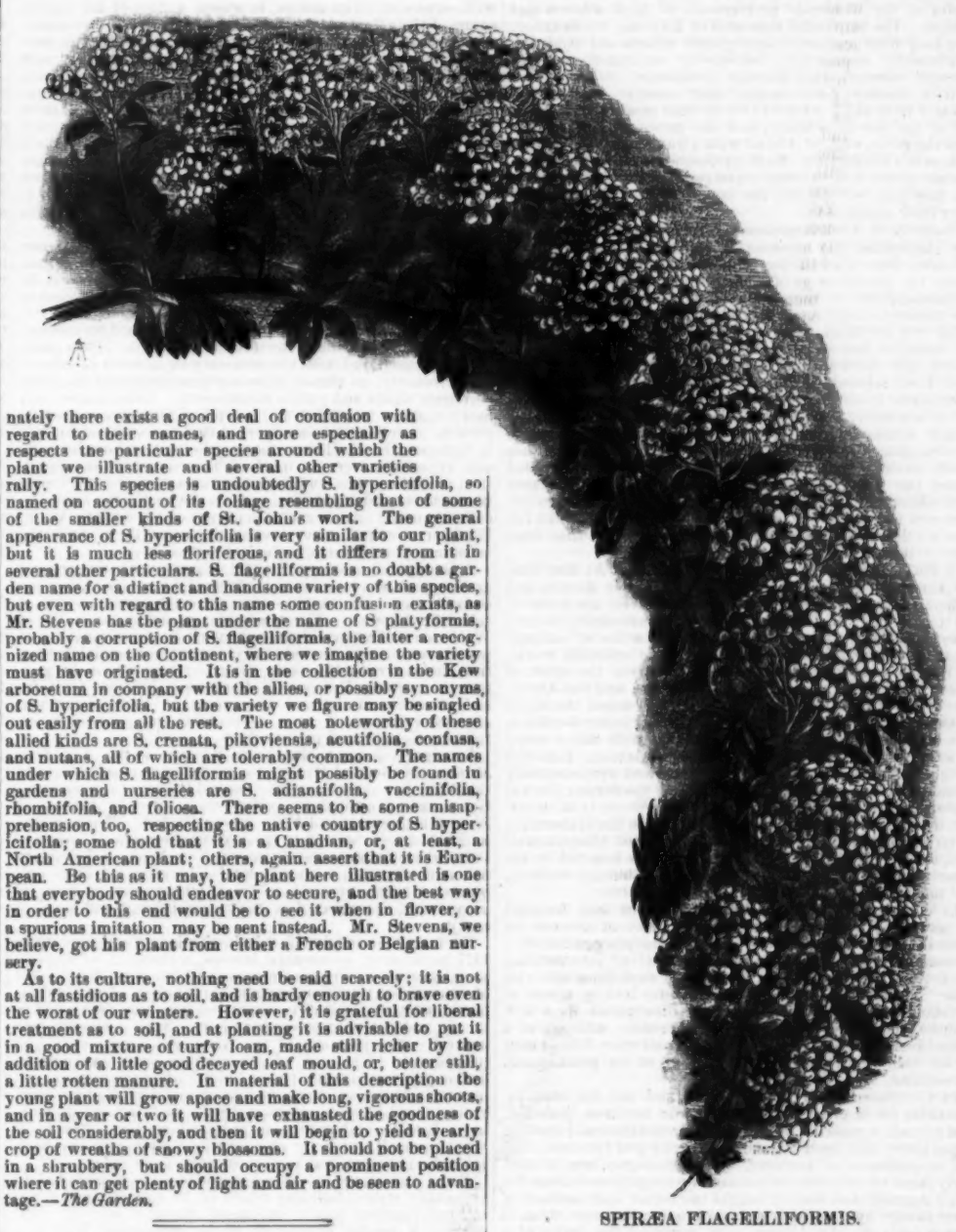
The same data which made sensible the service of modulations with the insane will explain the propriety of doctoring any of the other disturbances of the nervous system, particularly the functional, with minstrel performances. The notion that mirth is bracing and that the hornpipe mocks a funeral is no raw increment to reason's capital. The ancients had a saw that the three best physicians were "*mens laeta*, requies, dieta moderata." Macbeth, when he "throws physic to the dogs," forgot to ask for pipes and whistles. The charms of music are as far-famed as Eden's serpent. In sickness its persuasiveness seems irrepressible, and full many a time when decay is long spun out and death defers his call to fill full the cup of gnawing weariness, harmony comes as pain's seducer. To those suffering ideal ills, or who can call up any ache at leisure, the dyspeptic, the man with clogged liver or big spleen, the brigade of victims not of youthful indiscretions, but inmates of painted sepulchers and patrons of white-robed medicasters, to all these pilgrims of Despond some terpsichorean strains, the soul-stirring symphonies of a Mozart, the rollicking choruses of a darky troupe, the thrilling anthem, the melting ditty, will dispense the nepenthe that no drug depot ever inventoried. The story told of Farinelli curing Philip of Spain of suicidal intentions, induced by ill health, is a valuable confirmation of the possibility of controlling nervous depression by sonatas. Philip had passed into a state of profound despondency, continuing thus for days, secluded, not even willing to have an attendant to shave him. The Queen, confident that music would unyoke the bond of cold melancholy, ordered a concert to be given in a room near the King's chamber. The ravishing warbles of Farinelli at once overcame the King, who ordered the singer into his audience. Farinelli continued the soft impeachment until the King consented to resume his duties, was shaved, and appeared in public. To make the cure genuine, the Queen required Farinelli to sing daily for some time. No return of the "blues" to Philip, King of Spain, was ever afterward noticed. The affection mal de pays, or nostalgia, is said to be greatly amenable to minstrel ditties—the banjo may yet be found a specific for homesickness. With the Romans female musicians or psaltriæ were hired to play before the love-lorn; the Swiss were fired from withering despair to courage dreadless by the Rans des Vaches; the Pibroch made the Scot wax hot to die a hero. It is not the courage of wild fiction to conclude that the South Germans rarely resort to suicide because of music's grip on madness, and more than one to-day whose griefs of digestion or cultivated cough has made a rover after Siloam's waters, would forget all twinges if once moved by the electric trills of a Jenny Lind, a Gottschalk or a Paganini. The gospel of sweet rhyme has not yet been proclaimed of all its affluence. The rewards of song will not be ripe, nor can its coronation be confirmed until the energy hid away in music's sanctuary is brought out, and made to combat every pain that does violence to temperate reason or nice content.—*N. E. Med. Monthly.*

A NON-CONDUCTOR of electricity has yet to be found, for all substances hitherto discovered are conductors of the force under certain known conditions; but those which offer a great resistance to it serve the purpose of non-conductors in practice, although they may be all classed as good or bad conductors. The best conductor known at present is silver; the worst conductor is solid paraffine.

SPIRÆA FLAGELLIFORMIS.

A GLANCE at the annexed illustration will make our readers better acquainted with the elegant beauty of this Spiræa than any written description could possibly do so. It is, we consider, one of the most beautiful of all Spiræas, and unquestionably the finest of the white flowering kinds. We met with it last summer in Mr. Joseph Stevens' richly stocked garden at Grasmere, Byfleet, and thought at the time that we had rarely seen a shrub possessing such a combination of gracefulness and beauty. From a spray of this bush our drawing was made. It is a slender growing, wiry twigged shrub, ranging from 3 feet to 6 feet in height in favorable soils and localities. During the latter part of May and the beginning of June each of the preceding year's shoots is densely wreathed with small, erect clusters of white flowers as in the spray shown in the illustration. When a good sized bush is thus furnished with blossoms, its beautiful appearance may be better imagined than described. This Spiræa belongs to that section of the shrubby class characterized by their flowers being produced in hemispherical corymbs or loose umbels. These species and varieties belonging to this section are more numerous than in any other, and unfortunately there exists a good deal of confusion with regard to their names, and more especially as respects the particular species around which the plant we illustrate and several other varieties rally. This species is undoubtedly S. hypericifolia, so named on account of its foliage resembling that of some of the smaller kinds of St. John's wort. The general appearance of S. hypericifolia is very similar to our plant, but it is much less floriferous, and it differs from it in several other particulars. S. flagelliformis is no doubt a garden name for a distinct and handsome variety of this species, but even with regard to this name some confusion exists, as Mr. Stevens has the plant under the name of S platyformis, probably a corruption of S. flagelliformis, the latter a recognized name on the Continent, where we imagine the variety must have originated. It is in the collection in the Kew arboretum in company with the allies, or possibly synonyms, of S. hypericifolia, but the variety we figure may be singled out easily from all the rest. The most noteworthy of these allied kinds are S. crenata, pikoviensis, acutifolia, confusa, and nutans, all of which are tolerably common. The names under which S. flagelliformis might possibly be found in gardens and nurseries are S. adiantifolia, vaccinifolia, rhombifolia, and foliosa. There seems to be some misapprehension, too, respecting the native country of S. hypericifolia; some hold that it is a Canadian, or, at least, a North American plant; others, again, assert that it is European. Be this as it may, the plant here illustrated is one that everybody should endeavor to secure, and the best way in order to this end would be to see it when in flower, or a spurious imitation may be sent instead. Mr. Stevens, we believe, got his plant from either a French or Belgian nursery.

As to its culture, nothing need be said scarcely; it is not at all fastidious as to soil, and is hardy enough to brave even the worst of our winters. However, it is grateful for liberal treatment as to soil, and at planting it is advisable to put it in a good mixture of turfy loam, made still richer by the addition of a little good decayed leaf mould, or, better still, a little rotten manure. In material of this description the young plant will grow apace and make long, vigorous shoots, and in a year or two it will have exhausted the goodness of the soil considerably, and then it will begin to yield a yearly crop of wreaths of snowy blossoms. It should not be placed in a shrubbery, but should occupy a prominent position where it can get plenty of light and air and be seen to advantage.—*The Garden.*



SPIRÆA FLAGELLIFORMIS.

FLOWERS IN WINTER QUARTERS.

To the Editor of the Scientific American:

Flowers under the snow are an anomaly rarely met with. We associate them, rather, with the genial warmth of the spring and summer sun. Yet one of our commonest weeds, as will be seen, defies the frosts and even maintains its blossoms under the snows of winter.

My attention was called last autumn to the comparative sensitiveness of various plants to *cold*. While the least observant person will not fail to note the sad havoc which an unexpected and premature frost makes among his garden herbs, he may not observe that in the field succulent and delicate plants, and especially the ferns, share a like fate. One by one the wild flowers droop before the chilling breath of this destructive agent.

By the first of December, when Nature has laid aside her many-colored autumnal robe for her somber dress of brown, we find but few of the hardier plants still lingering. Among these was noticed the *Stellaria media*, Smith, or common chickweed. It continued to blossom up to the 3d of December, when in this latitude winter silently spread her mantle over the face of nature. Wishing to ascertain the condition of this plant in midwinter, some of it was excavated on the first of February, and was found in an apparently flourishing condition, though buried beneath a foot or more of snow. A close examination showed it to be in possession of buds, perfect flowers partially open (but for the most part closed as at night), and fruit in all stages of development. The dull green leaves and tumid stems suggest a decidedly frozen condition, but the tendency to wilt may be overcome by placing the plants in cold water immediately after their removal from the ground. They may afterward be dried or kept in water, when the buds and flowers will gradually steal open.

In this introduced and inconspicuous weed, we have an example of a plant which does not succumb to the cauterizing frosts and snows of our northern winter, but preserves its blossoms uninjured in the snow. Its persistency is most remarkable. The last to close in autumn, it is the first to unfold its petals in the spring, and may be seen in blossom in favorable places, where the snow has disappeared, on any warm winter's day. It seems thus to be more of a *perennial* than an *annual* plant. Possibly the *Capsella bursa-pastoris*, Moench., which we have seen in flower in the latter part of November, and other plants of this hardy nature, may have a similar history.

Those, however, which we have mentioned have their rivals for hardihood, among which may be noted the *Hamamelis virginica*, L., or witch hazel. Its bright yellow tassels, hardly noticeable at another time, are then conspicuous both by their uncouth shape and by appearing when its own leaves are sere, on the very verge of winter.

The plant which on the whole should be considered the harbinger or usher of spring is the *Symplocarpus fœtidus*, Salist, an enterprising but obnoxious herb; it pushes up its horn-shaped spathe in some seasons by the last of February, and appears in flower in March, while the snow is still retreating. Its own advancement may serve to test the progress of spring.

It is not likely that vegetable life wholly ceases at any time of the year. The buds of many trees gain in size every warm day through the winter. Those of *Salix discolor*, Muhl., may be seen considerably expanded by the first of February. The aquatic plants, also, which are slowly and imperceptibly unfolding, are quickened by the advent of spring. Lower orders might be mentioned, such as *lichens*, which are perennial in all latitudes, being so indifferent to temperature as to abound above the snow line of mountains, and requiring little but pure air and moisture for their sustenance.

Thus the severity of winter, however it may conceal and retard the functions of vegetation, does not wholly suppress them.

F. H. HERRICK.

Rock Point, Burlington, Vt., Feb. 8, 1883.

THE SUNFLOWER.

THE sunflower does not turn with the sun, but a recent observer finds that a majority of the flowers do have a prevailing direction when opening. In the case of one of the perennial sunflowers (*Helianthus mollis*), of sixty-eight flowers, up to one time all had their heads inclining to the southeast. Three days after this, with seventy-three flowers open, twenty-one (among the older flowers) had advanced toward the northeast, their horizontal faces becoming nearly erect during the journey.

THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY.

By L. P. GRATACAP.

IN a limited sense, one indication of the spread of scientific culture could be found to-day in the wide distribution of museums throughout civilized nations. They appear like monoliths, over a country which has become imbued with the scientific spirit, here raised to the memory of some local worker, there stately monuments of cosmopolitan learning, which in the centers of commercial activity preserve alive the genius and the zeal of original research. All are nurtured by the same love of the actual and its relations and laws, and all embody the incessant spirit of observation, comparison, and knowledge.

In the United States, favored by natural causes, the variety and wealth of our natural resources, by the adoption of scientific instruction in our schools, by the practical habits and cultivated instinct of observation of our people, the liberality of general and State governments in organizing surveys, and the helpful impulse of lyceums, lectures, and societies, scientific museums increase rapidly.

Yet the rapid and uncontrolled creation of museums is not an unmixed benefit if it threatens to bring about as ludicrous results as the wholesale propagation of high schools and colleges. The provincial museums of England, for instance, have long been a scandal among their writers and students. Insufficiently maintained, defectively organized, without educated curators, they became storehouses of disordered oddities, motley monstrosities, and strange perversions. "Water from the Jordan" is worse than meaningless alongside of the jaw of a whale, and the association of a brick from the great wall of China with a human skull is neither obvious nor instructive. Such grotesque combinations existed some years ago in small country museums in England, and they may yet employ the ingenuity of visitors to discover their significance.

To-day New York possesses a museum which very creditably exemplifies the opposite of all this, where judgment and taste have guided the selection of its treasures, and where the munificence of a city has provided them with accommodations of unusual stability and appropriateness. The cabinets of the American Museum of Natural History in this city are filled with the visible material from which the biologist has evolved his kingdoms, classes, orders, genera, and species. Yet a few months ago few citizens of New York seemed conscious of its existence. The casual descriptions in the daily newspapers of its attractions and curiosities barely served the trivial purpose of separating it in their minds from the galaxy of shows whose chromatic horrors amazed them in the Bowery or on Broadway. It has slowly grown upon public attention and become enrolled among the "objects of interest" of New York. A glance at its history, and the importance and character of its collections and their previous owners, will supply a want still felt after all the varied descriptions of its possessions that from time to time have been published.

In 1867 New York was without a museum. At that time the American Academy of Arts and Sciences in Boston had gathered together large collections which were the pride of the city. They had been studied, and investigations provoked by them had formed a continuous series of original inquiries that were known throughout the scientific world. In Philadelphia Franklin had early imparted the spirit of research to a generation of ardent admirers, and the American Philosophical Society had vigorously pushed the limits of their studies into unexplored domains of natural science. The Philadelphia Academy of Sciences, with wider scope of subjects and less esoteric in its organization, followed upon the footsteps of the elder society and systematically formed a museum and library, of which the former, in the abundance of its material in certain directions, is of unexcelled richness and beauty, and the latter, in the elaboration of its literary facilities, forms a monument of bibliographic lore, skill, and utility. These societies were fostered by the generous associated support of the best men, hardest workers, and most enlightened readers in each city.

In Washington the Englishman, Smithson, had founded an institution of exact learning and a place of deposit for natural treasures, which soon assumed the prerogative of a national instructor and became a channel of international intercourse between bodies of laborious experimentalists on either continent. In Chicago a museum had by a sort of spontaneous birth assumed mature dimensions in a few months, and elected to itself the countenance and aid of a scientific association. Stimpson conferred upon it the luster of his own reputation and the charm of his geniality and earnestness.

In Cincinnati, a city of collectors, and not the least remarkable for a great deal of scientific pettiness, jealousy, and conceit, a museum of admirable proportions and positive importance had been organized. It enjoyed for some time the co-operation of Anthony, the conchologist, one of that early band of scientific missionaries who gathered about the older Agassiz, and having caught the fervor and method of their master by a self-imposed commission imparted them to new proselytes. In Albany were garnered the fruits of a remarkable and classic survey, and Hall and Whitfield continuously published new illustrations of their fullness and interest.

Coteries of scientific men indulging their private hobbies and enjoying mutual encomiums in their evening conferences were numerous in all large cities, but even in these New York was poor.

A philosophical society had expired forty years before in giving birth to an exhaustive summary of its claims to existence. The New York Lyceum succeeded to its desolate title, and stimulated by the genius of Torrey, Draper, Wheatley, Redfield, and Dekay, had drawn to itself all the serviceable elements of a scientific association, and brought together from a variety of local contributors the nucleus of a museum. It fluctuated in a precarious manner between extinction and prominence, periods of vitality alternating with fits of moribund inaction. Its collections were destroyed by fire in 1865 in the conflagration which swept away the old College of Physicians and Surgeons, and its demoralized members have only recently revived its failing influence under the observant guidance of Newberry, Marten, and Julien. A band of local antiquarians, embracing an impressive membership, had also tried its fortunes at figuring before New York as the American Ethnological Society, but it encountered a reception so hopelessly dreary that after the momentary excitement of resolving itself into the American Anthropological Institute it expired. The New York Historical and Geographical Societies two quasi scientific bodies, maintained an unobtrusive vitality.

Amid the prevalence of scientific enthusiasm, culture, and proprietary gains around it New York diligently plied its trade of money-making and won the wages of an unflagging laborer. Yet the examples of deliberate patronage of science, and of the public spirit which built free halls of science for popular instruction at home and abroad, exerted an improving influence upon the mind of New York. At a propitious moment, and at the suggestion of a few men, the American Museum of Natural History was founded.

The Central Park at that time had engaged the attention of our citizens in a manner calculated to flatter their pride and excite their ambition, and every new project connected with it was applauded. What a culminating pinnacle of unique fitness would be touched if a museum for the elevation of the people should be placed in the midst of a pleasure ground of unexampled elegance and tastefulness.

Another auxiliary impulse in this direction may have existed. Mr. Waterhouse Hawkins, a learned anatomist, whose hereditary possession of a vivid imagination had been somewhat disordered by a study of extinct forms of life, reveled in the thought of crowding some spacious arena with his graphic restorations. Perhaps to the very mundane minds of the luminaries of the Tweed Ring the plan of a Pantheon of bony horrors, in which the Mylodon and Megatherium led a retinue of appalling night mares, materialized in plaster and paint, possessed elements of phenomenal loveliness. However that may be, Mr. Hawkins was provided with some sort of an atelier, in which a few of his studies assumed their final proportions, but the finale of this undertaking was humiliating and unexpected. Judge Hilton, possibly incensed at the idolatrous dimensions of these "new Gods," or at the tedious process by which they were evolved, fulminated a bull against them—*reprobati proscripta atque damnati*—and under the indiscriminating hammers of park laborers their fragile members perished. A few drawing models were rescued, and some now to be seen in the School of Mines in this city revive no regret that their multiplication met so signal a check. This impracticable enterprise was a dim adumbration of the Museum which followed, at least in its spirit, and it rendered a valuable service in this direction.

In the mean while informal conferences were held between a few gentlemen—R. L. Stuart, J. S. Steward, T. Roosevelt, and H. Haines—invoked and abetted by Professor A. S. Bickmore, which led to a wider agitation of the proposal to have a great museum in New York city. Names for a roll of members, a subscription list, and the formless enthusiasm of a crowd of friends to the project followed. Then came prompt action, and with the necessary equipment of officers and a treasury, an almost impromptu organization assumed corporate rights and public significance. Coincidences and lucky chances pervaded its inception and encouraged its growth. Large collections were at that time offered for sale in Europe. Dr. G. Elliott, the ornithologist, whose learning and experience were of incalculable importance at this critical moment, when stupid expenditures would have crippled its resources and reputation, was on the spot. He knew the collections and advising with the agent of the Society, W. T. Blodgett, secured some invaluable material, in fact the substance of its present zoological possessions.

A showy but not very fruitful alliance with the general government was temporarily effected, by which American consuls were put under orders to send home objects of scientific interest. The venerable name of John David Wolfe, as its first president, supported by a brilliant list of prominent citizens, served to give the museum social distinction, and a graduated scale of subscribers whose designations as patrons, Fellows in Perpetuity, Fellows for Life, and members announced the extent of their donations, afterward helped it to a substantial *res pecuniaria* for future purchases and present debts.

Incorporated as a society to be known as the American Museum of Natural History by an Act of the Legislature of the State, it was welcomed to Central Park by Commissioner Green, and deposited its collections in the old Arsenal at Sixty-fourth Street and Fifth Avenue in 1869. Those walls, which had reverberated to the martial grounding of arms in 1863, when riot held the throat of New York in its bloody fist, now witnessed a more peaceful invasion of birds and beasts, a silent procession, from whose mute forms, as named and classified, flow the tranquillizing influence of study.

Such was the origin of this institution; its history up to 1877 partakes of no essential interest, a chronicle of acquisitions, increased revenues, increased attendance. No element of educational intention, speculative inquiry, or any serious participation in scientific discussion had been developed in it. It had no perceptive functions. Such dormancy was natural. Its occupancy of the Arsenal was temporary and provisional. The time of its curators was employed in devising room, in anticipating additions, preserving specimens, formulating needs and mechanical appliances, renovating, stuffing, and poisoning objects, packing and unpacking. It had no laboratory, no publications, had allied itself with no professed body of scientific students or thinkers. Its immediate care was to keep its collections safe.

From the outset of this enterprise it was intended to eventually erect a building which in its capacity and architectural features would command attention, and by permitting a proper exhibition of its collections lead to a scientific revival in New York. Nobler purposes mingled with these ambitious hopes—the people of New York, the clerks, the artisans, the multitudinous workers of a metropolis were to find recreation in its spacious halls, to see the treasures of the visible world and to read their lessons. The Museum of Art, a similar society, originating about the same time, and with similar motives in its programme of usefulness, needed an appropriate and permanent home. The important interests represented in these sister bodies, thus momentarily united, were brought to bear upon the Legislature in the most forcible and persuasive manner.

A monster petition was prepared upon whose voluminous rolls was seen 40,000 names, a body of august supplicants made up of what was best and most valuable in New York society. The petition begged for an appropriation sufficient to begin the building of an Art and Scientific Museum, and the unanimity of the appeal, its extraordinary strength, brought almost instant acquiescence to its requests.

In 1874 the corner-stone of a new building was laid in Manhattan Square—truly at that time *rudis indigestaque moles*—and plans of exorbitant magnitude had been prepared for its indefinite growth through a coming century. President Grant laid the corner-stone, Governor Dix mingled classic allusions and political compliments over its foundation, the wise Henry sketched the fitting lines of its development, and a fashionable concourse of people heard each new prediction of its importance with delight.

It was in June. A large platform covered the newly laid walls of the foundation, and above this rose their unfinished and irregular edges inclosing a space crowded to its limits with expectant guests. A canopy over all tempered the propitious radiance of a summer sun; platoons of police kept open broad avenues of approach, and the constant roll of equipages and the occasional appearance of groups of distinguished men lent to the occasion an unusual and gala character. The scene was in reality not without a certain impressive and picturesque interest. Without the inclosure, the square, then broken by outcropping strata of gneiss rock and valley-like basins, was black with throngs of men for whom was then instituted a place of beneficial recreation; within, an assembly of beauty and culture, wisdom, and executive perogative engaged in a ceremony contemplating honor solely to the genius of modern civilization.

The event was recorded in the daily papers with unrepressed satisfaction, and for a moment the trustees of the Museum controlled and held public attention. The present position of the Museum, its building, its collections and the bold plans of its architect—Calvert Vaux—are noteworthy.

Manhattan Square is the name given to 18 acres of land west of Central Park between Eighth and Ninth Avenues and Seventy-seventh and Eighty-first Streets. At an early day it was selected from the region about it, and reserved to form a pendant to the great park opposite, to be used as a place for some sort of free entertainment and early associated with schemes of grotesque magnificence.

When the somewhat distorted imaginings of Mr. Hawkins fascinated the fancy of the Department of Parks, it was expected to utilize this large space for a species of Sydenham Palace copied upon a monstrous and redundant scale.

Here a bear-pit of enormous dimensions was to be sunk surrounded by caves for its ursine tenants; above this arena a cyclopean amphitheater of appropriate ruggedness; outside a posse of beavers were to engage their natural instincts in building a dam, and under the stimulus of public applause erect it upon a scale of surpassing grandeur; near them was to be contained "a miniature frozen lake peopled by polar bears, seals, wolves, and other creatures of great and pleasing interest."

This was not all. The natural inequalities of the ground—the hills and holes—artificially diversified by lawns and terraces, were to be adroitly made subservient to the picturesque and startling contrasts which should abound on every side; it was to be a combination of surprises and enchantments, a fairy land, a microcosm of travel, a kaleidoscope of shows. Nothing less; we read in the *Evening Mail*, Wednesday, Oct. 27, 1869, "Caves with graceful tenants will surprise at every turn, tiny cascades will tumble down the rocks, wonders of the finny tribes will glisten in miniature lake and sedgy pool, and among the shadowy foliage overhead rare birds of gorgeous plumage will talk to us in unknown tongues."

In addition the flexible and soaring minds of the originators of this project contemplated a gloomy and half subterranean receptacle for Mr. Hawkins' restorations, a kind of anatomical catacombs wherein the shapes of preadamite life would be dimly descried, and from which it was expected the visitor would emerge oppressed by mingled sensations of fear and pleasure.

"Disturbed, delighted, raised, refined."

New York was spared this theatrical and useless episode.

To day Manhattan Square is emerging from its previous condition of desolate neglect; gentle and interblending slopes undulate its surface and serpentine walks sweep between and around them. Trees and lawns will succeed, and in a year the imposing structure of the Museum will be seen over a verdant plain through which from all sides graceful paths will lead to its entrances. The region around is an unsettled district in transitu to something permanent and homogeneous. It is compounded in its pictorial aspect of several discordant yet picturesque elements; it embraces old farms, ruinous landmarks of ancient New York, brand new stores and the most sanitary of modern tenements, bewildering mazes of hovels cluttered together over swelling knobs of rocky ledges and pretty kitchen gardens lying in its deep depressions. The banks of the Hudson retain in places woods as old as New Amsterdam, and the daily stage which rolls up the spacious boulevard to Manhattanville adds a suggestive touch of antiquity to all.

The architecture of the building is perhaps striking, its position gives it a bold relief and a certain incongruity between it, and its surroundings heightens its saliency in the landscape. It can hardly lay any claim to structural beauty; an impressive solidity conjoined with a dwarfing sense of incompleteness at first disappoint the visitor until he realizes that exterior effect has been exchanged for interior convenience, and that this edifice only represents a fraction of the final colossus it foreshadows. In detail it is a building 170 feet long, 60 feet wide, rising 101 feet to its eaves, built of brick cut by four lines of syenite, developing into ledgeways beneath the windows, its water table of ponderous blocks of syenite, the frames and lintels of the windows of the same, the floors massively constructed of iron, the internal frame made of iron, and for foundation a solid gneiss ledge upon whose unyielding floor rises the masonry that sustains the whole. From its mansard roof to its paved cellar its builders have endeavored to secure three requisites, and in such a combination that none will supplant or limit the rest, strength, room, and light.

The simplicity of its arrangement within corresponds to the plainness of its exterior, three capacious and even stately halls—one with a gallery—form its floors, surmounted by a fourth floor on which are a series of large rooms for libraries, storage, and special work, and above this again immediately under the roof a commodious attic. A tower-like expansion at the northern end contains the broad stairways which lead in iron flights from story to story. Immense windows form one-third of the outside area of the Museum's walls, and through them pours a flood of daylight that gives to the smallest object distinctness and brilliancy. Decoration has been disregarded. The elaborate designs and sinuous intricacies of Alfred Waterhouse's complex symboliam in the new National Museum in London are absent here, not even suggested.

The original plan for the entire edifice was that of a hollow square whose sides were to be formed of four great buildings 500 feet long, more ornate in material and detail, and distinguished by large entrances of architectural dignity and strength. The present structure faintly suggests the stupendous proportions contemplated for the complete building. It represents indeed only the fourteenth part of it, and a subordinate part as well. The whole structure would cover 15 acres and cover a space three times larger than the basement area of the British Museum.

A building of this great size with its long hallways filled with classified collections would embrace the most diverse and opposite kingdoms of nature, illustrating all even to their minute details. The exact sciences might here find a home, and the technical appliances in the arts room for the exhibi-

tion of their numberless adaptations. The world would be its contributor, the nation its patron, and in the most perfect condition of usefulness and vigor its lecture rooms would be the schoolhouse of the people.

On the ground floor of the present building is a large collection of mammals, an excellent though restricted collection in comparative anatomy, and the shells of Dr. John Jay. In these cases in a serial line of ascension are found the representatives of mammalian life from the almost isolated group of marsupials in Australia to its zoological apex in the quadrumana. Among these are gems of taxidermy, artistic treasures, and from the hand of a master. This fawn with uplifted leg and lowered head, whose "fixture of the eye has motion in it," the flexile posture of the body, wherein the lines of grace are moulded upon a frame of sinewy vigor, the nervous limbs, a picture of mercurial and arrowy fleetness, is from the hands of the pupils of Jules Verreaux, who was a Raphael among taxidermists; his works have the poetry of nature underlaid by an unerring instinct of anatomical relations. The angularities of structure are not forgotten in them, and smooth contours are broken by lines of modeling. This subtle realism made him unique; he was truly *craisemblable*. He was a polished workman guided by affection, a just sense of proportion, and by a memory that kept

"All forms, all pressures past
That youth and observation copied there."

Mr. Holliday's work on the group of orang outang is also superb. Taxidermists are apt to overstuff; if the subjects are large they are fattened with superabundant straw until, like Falstaff, they are "mountains of mummy;" if small, converted into rolling pins. Taxidermy, like sculpture, is a study of the relations of muscles. With little difficulty it becomes the protean art of making pin cushions.

This cabinet of mammals is justly celebrated. They equal or excel in number and quality the large collections in most of the European museums, though dwindling into insignificance when compared with those of Kensington, the Jardin des Plantes, or the exhaustive cabinets at Berlin. In our own country they are unexcelled, and it should be one pride of the Museum's trustees to maintain this supremacy, and, by adding enough material, permit the arrangement of the collection under geographical areas. For to-day, next to the supreme interest felt in embryological study comes that elicited by the problems of the distribution of life over the globe; in other words, the question of where upon the earth are found identical specific forms and the relations of the regions they occupy.

Once we were taught to think that there was a sort of zonal arrangement by which similar animals from either pole to the equator were conveniently quartered at regular intervals of latitude and were as exclusively confined in these appropriate plats as though each parallel was a picket fence, and each meridian a stone wall. But no such symmetry exists. The lines that mark out zoological regions are drawn by the balancing pressure of numerous influences; they follow the directions of storm, the configuration of continents, the character of the soil, the drift of tides, the relations of woodland and plain, the trend of mountains, the character of vegetation, the abundance or scarcity of food, its kind and quality, and most strikingly of all, they have been bent and broken by past geological changes. The subject is fascinating. The coincidences of certain animal types in widely separated portions of the world, the varying influence of temperature and geographical boundaries, the traces of migration, all provoke guesses over those prehistoric movements in the animal world that upon sea and continent followed the mutations of climate and terrestrial change.

This admirable nucleus of mammals has been constantly enlarged by the gifts of individuals, and the Museum is indebted to such generosity for its rotund and vigorous group of bison, the mountain sheep, the hooded seal, the camel, wapiti, and moose, and the realistic picture of the orang outang disporting amid the mimic foliage of the durion trees of Borneo.

The collection of shells arranged in table cases on this floor is the larger part of Dr. John Jay's, which that gentleman gathered together mostly by purchases, and which served for many years to vary the monotony of his professional life. As a collection, it attained considerable celebrity, and many delightful hours of social and scientific talk have been passed over its specialties by its owner with distinguished naturalists. A large number of the unios or fresh-water clams belonging to Dr. Jay had been used by Lea in his famous monograph on this family of shells, and numerous references to his specimens are scattered up and down on the pages of special writers. The successive editions of his catalogues, prepared with a considerate care that made them useful tables of reference, will be kindly remembered by the members of the K. K. Club of New York, and the less erudite amateurs of Brooklyn in the halcyon days before Adams and Chenu had rendered the system of Lamarck a snare and a delusion, and when the Tontine on Water Street beguiled the eager dilettante with a meridional sandwich before plunging into Norris' on Maiden Lane for a new debutante from the Caribbean or South Pacific.

A portion of Mr. W. Haines' collection of shells, selected from the superb cabinet of that gentleman, are shown in some few desk cases. These groups are like a painter's palette in the variety and contrasts of their color, and the elegance of their shapes adds another and a higher charm. Here are the nacreous and pearly tints of the cones with their exquisite tessellations, the waving lines of ornamentation and mitered summits of the volutes, the bright variegation of the helices and bulimi, the coral-red pectens, the white spondylus with its frills and spines, the glow of yellow cypræas, the architectural symmetry of the scalaria, the richly-striped convolutions of the trochus, the cavernous and daintily stained strombi.

One modest case on this floor might escape the attention of the visitor were he to trust the allurements of color and form alone, which yet surpasses in its significance almost all around it. It contains a sober group of land shells, demure and monotonous in appearance, but invaluable and sacred to the reverent minded naturalist as the visible tokens of study and earnest research. These homely objects have undergone the close and exhaustive examination of Binney and Bland, the eminent students of terrestrial conchology, and their varying features have been recorded, named, and described; each delicate flexure of the lip, marking of the shell, contour of the whorl has been given importance through their scrutiny. They have become types to which all similar forms may be referred for identification, their names have established the species they indicate, and each minutia of their construction, like the flaws and peculiarities of an old manuscript in literature, has become stereotyped in science.

This floor affords an example repeated everywhere else we go of the completeness of the lighting properties of the building. A flood of light is diffused through the hall, penetrates every recess, and permits nothing to escape its searching illumination. Every one who has attempted to favorably exhibit objects for purposes of study will recall the aggravating penumbræ, interferences, and cross-lights which hid or misrepresented the specimens, and to them the sunny luminous atmosphere of these halls with its unimpeded suffusion over everything in its glow and brilliancy will appear almost unexampled. The best museums of our own country and many of the best abroad are rendered practically useless by the gloomy corners, dark shadows, and wavering reflections, arising from cramped quarters, parsimony in lighting space, and a complete neglect of the proper relations between the direction of the light and the size, location, and appurtenances of their cabinets. Many hallways in the Smithsonian Institution recall the crepuscular beauty of that dim religious light associated with the meditations of the worshiper, and never with the alert and watchful inspection of a student curiously hunting for an identification of a limpet or the classical appellation of a titmouse.

The second floor of the Museum holds the cabinets of birds, and as we enter the broad doorway the coup d'œil over the polished floor along the fronts of the cases filled with mingling colors and myriad forms blending into a perplexing maze, and up to the overhanging galleries, the wide patio-like space between them and the descending sheaves of light entering from above, is striking and admirable. This immense and brilliant collection apart from its intrinsic beauty is full of interest from its association with the works and travels of two distinguished ornithologists, one of whom has become the subject of picturesque and pleasant memories. D. G. Elliott, the facile author of the resplendent monographs on the ant, thrushes, and the grouse, those crown jewels in the library of the ornithologist, and the laborious compiler of the reviews of the families of the humming birds and the horn-bills, sold the collection of North American birds to the Museum. Many western forms are absent, also the obscure hybrids from along the line of two neighboring zoological sections, and later arrivals from the aberrant intrusion of southern immigrants, but they form a capital representative illustration of North American ornithology and a few notable examples—as the great auk and labrador duck—confer upon it distinction.

Almost all the remainder of the collection belonged to Prince Alexander Philipp Maximilian, of New-Wied, the royal naturalist who visited Brazil in 1815, exploring it through ten degrees of latitude, penetrating to the limits of Minas Geraes, through a region of

"Antres vast and deserts idle,
Rough quarries, rocks and hills whose heads touch heaven,"

and industriously gathering the animals and birds of its redundant fauna. In 1832, he visited the United States.

This painstaking German of royal lineage, destined for a gentler life and a less extreme fate than his ill-starred namesake, was born in 1782, and from boyhood manifested the most ardent devotion for natural history. The inflexible traditions of his family and position, conjoined with the exigencies of the day when Germany confronted the rampant ambition of the first Napoleon, forced upon him a military life, which he forsook upon the conclusion of the peace of Vienna, and began those extended travels of which he has left us such voluminous narratives.

His books are readable, they are simple chronicles, often showing the laconic repression of a traveler's diary, and again replete with description and the zest and sparkle of true enjoyment.

When Maximilian visited America little was known of that vast far West whose lonely wilds had become the refuge of the Indian, where his sullenly retreating peoples vanished, keeping yet alive the keen spirit of his ancestral cultus. Romance had enwoven its mysterious and wonderful beauty into fictions of fabulous adventure and rugged manhood, a veil of weird wonder covered it, its very name touched the imagination with nameless longings. None of its possibilities were known, the broad prairies of Dakota had not yet heard the scream of the steam thrasher, the bowels of its mountain had not been burrowed along the enlacing network of their silver veins, nor its streams turned from their primeval beds to reveal the golden sands they had washed for ages.

Major Long, Lewis and Clark had made two visits to the Northwest, both memorable excursions. They told the Eastern world much of the character, denizens, and marvels of the West, but they were of necessity fragmentary and provisional. Maximilian's visit was that of an experienced naturalist. He had come a long way, and expectation had wrought his mind up to a pitch of wakeful attention. His contributions, therefore, to our knowledge promised to be at that time of great value. He visited the region between the Mississippi and the Rocky Mountains, and he explored the upper parts of the Missouri. Perhaps the greatest importance should be attached to his intercourse for over one winter with the aborigines of the Upper Missouri, the Mandans, Manitous, Assiniboins, and Blackfeet tribes, which, shortly after his return, were destroyed by small pox, and lost irretrievably the expression of sylvan wildness, strength, and ethnic unity which they wore when he saw them.* Maximilian's diaries and notes were all he brought back; he lost his collections, which were burnt on their way to St. Louis, a loss to science and a sad disappointment to their disheartened owner.

The Maximilian collection of birds is as yet scarcely known to ornithologists. There seems reason to suppose that when it is examined some of the unusual nomenclature and unknown determinations now seen in it, as given by Maximilian, will be found to hide new species, and in any case its study and classification cannot but afford interesting results as a commentary upon the methods and learning of its collector. The section of the South American birds deserves the most critical attention, and may repay the emulous species-maker with here and there a trophy for his refined powers, and furnish him with a desirable immortality upon the check-lists and revisions of the future compiler.

The immediate impression upon the less learned eye of the layman is bewildering; the endless contrasts of forms, the wealth of color, the modifications of structure, the singular ornamentations and whimsical conceits amaze and delight him. And how many cherished recollections are reawakened by these more familiar shapes—recollections which illuminate the past with bright periods of robust and healthy pleasure, or frame it in delight like the radiant margin of a missal. Whether we followed the piping snipe over drear marshes in the red light of autumnal sunsets, startled the brooding partridges from under snow-laden pines, crept through wild brier and viburnum to steal the turquoise eggs of the thrush, or from some knob of land overlooking sleeping valleys watched the eddying hawk "when it is moving on luxurious wings."

The gallery above the bird floor in the Museum forms the Hall of Archæology and Ethnology. It contains three remarkable collections and a great number of interesting relics and objects gathered from small handfuls of antiquities bought or contributed from time to time and put into pocket-like exhibits throughout the hall.

The first important collection is the De Morgan cabinet of stone implements from the Somme Valley of northern and from the cave districts of southern France.

The Somme River flows through Picardy to the Atlantic Ocean. It is a small stream winding at the foot of sinuous ridges of low hills and between wide marshes, bogs, and lowlands, in a country diversified by farms, villages, and an occasional chateau. On its banks are the pretty cities of Amiens and Abbeville, whose gleaming cathedral spires catch the eye of the tourist as he approaches them over winding roads. The country is overlaid by gravel sand-banks and alluvium, and beneath lies the eroded and undulate beds of the chalk, and in the softly rounded basins thin deposits of Tertiary strata. Sepulchres of fossil bones had long been known along its banks, and studied by Cuvier, had conferred upon the locality a scientific fame. Boucher de Perthes first noticed in the suburbs of Abbeville the evidences of human occupation of this valley at a time when extinct animals roamed through it. He collected from the gravel beds, the quarries, the exposures about Abbeville, hundreds of roughly chipped flint objects, many twenty or thirty feet below the surface in undisturbed soil. He insisted that these rude and jagged objects were human implements—the battle axes, casse-tetes, hammers, sledges of the antediluvian man. He worked unceasingly, every notable digging he watched, he completed many himself, and he patiently gathered, compared, and described an extraordinary collection of the paleolithic implements and the circumstances of their exhumation.

Boucher de Perthes was an amiable and a not inconspicuous *litterateur*. Antiquarian lore, history, and poetry, in fact, the wide circle of belles-lettres embraced him as a contributor, and only accident diverted his attention to a subject with which his name is now inseparably associated, and which will perpetuate it far beyond the narrow limits of his literary reputation. He recognized in the flints of this region an artificial form impressed by a designing workman, and he recognized their antiquity from certain geological relations in which they stood as well as by their position in reference to the Gallo-Roman remains which are occasionally found in the peaty plains at the river's brink.

This much he caught at a glance, and his convictions partook of just that incisive nature which clear first impressions always assume, and he maintained them for ten years against the contumely of the French Institute and the neglect of foreign investigators. Perhaps his works are partly to blame for this cold reception. His advocacy of his views was too ardent and unhesitating, and he enrolled them often in a fog of unnecessary vagaries. The "L'Industrie Primitive," published in 1846, was also too voluminous a work for the irritated and interested skepticism of its readers. A shorter, less discursive, and more modest statement might have had more weight. Boucher de Perthes seemed to be an exalted zealot afflicted slightly with an influenza of poetic hallucinations. His book was scarcely read. He still persevered, and collected the flints in numerous series, and heaped up large stores. In 1857 he published the "Antiquites Celtiques," another large volume crowded with a great number of new facts and bearing witness to the change effected in public feeling during the ten years since his first work. Opinion had been shaken by the investigations of Dr. Rigollot, of Amiens, and by his sudden conversion, from hostility to the views of Boucher de Perthes, to an advocacy uncompromising and entire. Prestwich, Evans, Lyell, and Flower followed with an authoritative indorsement of Boucher de Perthes, and the contest was over. Since then the history of his explorations has become classic, the Somme valley and its relics the stock in trade of every writer upon the antiquity of man.

Until 1876 there was not in the United States any adequate representation of these celebrated implements, and the De Morgan collection is incomparably the best outside of France. The suite of St. Acheul axes is capital, and the polished almond-shaped scrapers, chisels, and adzes, of great perfection and beauty. The collection contains also many of those singular bits or chips marked "pieces rare et inconnus," which Boucher de Perthes looked upon as a sort of concrete or sign language, counters for ideas as well as the beginnings of pictorial art.

The second large collection is that of Col. Chas. C. Jones, of Georgia, who was, during the civil war, an officer in the confederate army, and who had previously studied the remains and civilization of the Southern Indians. The collection embraces arrow-heads, spear heads, javelins, hammers, the polished symmetrical Chungke-stones, with which the Indian athletes played such desperate games of chance that a player staked his own and his family's liberty upon the venture of a throw; ornate sculpture of calumets, enigmatical tablets and banner stones, agricultural implements, hoes and spades, tubes, urns, and vases, in short, the inventory of the wild man's goods in his art, his religion, and his industries. Book in hand, the visitor can inspect the implements which Col. Jones figures in his work where he narrates the circumstances or surroundings under which he obtained them, and few things are more pleasing to the connoisseur than actual contact with the *res integra*, of which the *verba scripta* are only a poor image.

Near these objects are a few and very precious relics, a remnant from the large collections made by Dr. Davis in Ohio, when he undertook, with Mr. E. G. Squier, the famous examination of the Western mounds. They embrace a small group of the remarkable mound pipes, and a variety of tokens obtained from mounds, all interesting and of historical moment as belonging to the first fruits of systematic archæological toil in this country.

American archæology is to-day attracting very considerable attention from all who study the relationship and origin of races, and few themes have caused more wonder or led to more persistent study than the mounds of the great Mississippi valley, with their kindred works scattered north and south. As early as 1775 Adair mentions the mounds in his travels, though his references are desultory and brief. In 1779, Bartram, the pioneer botanist, whose animated journal describes the author's vivid experiences in the thick tangles of Florida, speaks of those he saw in that region, and at the beginning of this century these strange erections, about

*Small pox destroyed 60,000 in a few months. The Mandans were exterminated; out of 1,500 30 survived. The disease spread with the rapidity of lightning, and the miserable victims sank before it in thousands. Their spirits were completely broken, their forces were gone, and the survivors crushed, terror-stricken, and abject, seemed only the dismal specters that haunted the cemetery of a nation.

which hovered the manes of extinct nations, attracted the curiosity of every traveler who encountered them.

Their existence challenged ingenuity to account for it, and wild guesses and sensational theories were more frequent than detailed examination of their contents, or carefully made diagrams of their form and location. De Witt Clinton contributed luster to their study by a paper of admirable clearness and intelligent appreciation as early as 1817, which appears in an early number of the Proceedings of the American Philosophical Society, and was succeeded by Caleb Atwater, who made the first useful survey of these tumuli, and by a galaxy of contributors, many of whom were distinguished professors of other branches of natural science, whose notices have been extorted by their excited and baffled fancies. Squier and Davis began their prolonged and exhaustive scrutiny in 1845. They visited and surveyed 1,000 works, inclosures, or gardens, and opened 200 mounds; they collected several thousand objects, and the results of their examination formed the material for the first volume of the Smithsonian Contributions to Knowledge, a significant opening to that dignified series of profuse and astute discussions.

The judicial character of their work, its excellent execution, and literary skill, obtained for it the widest influence, and scientific methods were by it engrafted upon the study of American archæology. It stimulated inquiry, awoke a dormant enthusiasm, and evoked the publication of many similar treatises, written by careful and old observers. It demonstrated the ancient occupancy of the Mississippi valley by a semi-civilized race, which had acquired some knowledge of exact science—the rudiments of trigonometrical measurements—and exercised striking gifts in portraiture and carving.

The third large collection is that of Mr. R. W. Sturgis—at present a loan collection—and fills the cases on the east side of the hall. They have all come from the sunny islands of the broad Pacific—those day-dreams realized—where the palms cast their brocade of interlacing shadows on the golden sands, and the white fringes of breaking waves gleam distantly over coral reefs.

"The mountain wooded to the peak, the lawns,
And winding glades, high up like ways to Heaven,
The slender cocoa's drooping crown of plumes,
The lightning flash of insects and of bird,
The luster of the long convolvuluses
That coiled around the stately stems and ran
Even to the limit of the land, the glows,
And glories of the broad belt of the world."

Here are illustrated arts of life, religious customs, games, ornaments, weapons, dress, the phases of a softened barbarism contrasted with ruder aspects of wild life, and scattered everywhere, hints of the penetrating processes of evolution, whereby old forms of tools are put to new uses, notions of design aroused and improved. Many are beautiful, more curious and unexpected. The paddles from the Hervey Islands have their surfaces covered with a fretwork of delicate helices, chevrons and hyphens, worthy of the toilsome industry of a Moor; the ceremonial axes of Mangaia are wonderful, the scythe-like batons from the Solomon Islands unique, and the heavy skull clubs of Samoa grotesque and barbaric. Perhaps nothing could surpass in its bizarre commixture of the incongruous, hideous, and absurd the masks of wood, glaringly painted and rudely cut, in which the natives of New Ireland appear, when preparing a surprise party for the aboriginal parson, or celebrating an annual bal-masqué.

Mr. Sturgis has exhausted invention in his hunt after these implements. He has not visited the islands himself, but has established a most successful series of repetitive proxies. These are the captains of whaling vessels, merchantmen, and all ships that pass or stop at any of the groups in the great Archipelago. Missionaries and friends, consuls and travelers, have been successfully interested, and we may believe the original artisan who made some of these remarkable weapons may have added a last dexterous touch when he heard the familiar name of the claimant to his workmanship.

In other sections the hall is crowded with very different things. This swarm of monotonous water-jugs are the pottery of the strange Mound Builders, these stone collars, nameless and inexplicable, are from Costa Rica, and these water crofts and tapestries may have enriched the bric-a-brac of a Peruvian Inca. Burial urns from Georgia, pueblo huts, carvings from Oregon, dresses from Canada, the furnishment of a medicine man's pharmacy, and an array of "new arrivals" from the west coast of Africa, with a running accompaniment of stone celts, pipes, perforated tablets, and ceremonial badges, complete the visitor's confusion in this archæological storehouse.

The uppermost hall in the Museum is the Hall of Geology. It is a handsome and impressive room, and its tall and wide Gothic arched windows illuminate it perfectly. It contains the celebrated Hall collection of fossils, of which Louis Agassiz said, "Whoever gets Hall's collection, gets the Geological Museum of America," and, which, shortly before his death, he attempted to purchase. They form the largest collection in this country, in point of numbers alone, and as an illustration of the very earliest periods recognized by geologists in which life existed, excel those in the world besides. It was almost entirely collected by Prof. Hall, with whose investigations as State Geologist of New York it is identified, as, in fact, much of it was brought together during the survey of this State.

The New York survey, inaugurated in 1836, marked an era in the history of geological science in this country, and yielded large contributions to natural history as well. The survey's relations to geology are the most obvious and in this connection the most important. It occurred at a period when scientific, rational, and comprehensive principles were being applied to the science; it availed itself of the great advances made in the study by the labors of Sedgewick, Murchison, De la Beche, Bishoff, Portlock, and Phillips in stratigraphy, and of the work of Agassiz, Lonsdale, Sowerby, McCoy, De Verneuil, De Keyserling, Eichwald, and others in palæontology, and it appropriated whatever had previously survived the test of criticism and observation from the surveys of McClure and Eaton in this country.

But it was itself the source of most original observations; it was made upon new ground and it supplied a wealth of material in palæontological data and the *rationale* of the earlier formations unequaled by any similar survey in the world. It demonstrated the existence in this State of a series of older formations whose parallel in the regularity of their succession and the clearness of their demarkation and limits could nowhere else be found.

Previously the contradictory labors of various Europeans and the more conscientious efforts of Prof. Eaton had been based upon a misleading presumption that the rocks of Europe should have their exact analogies in those of this country, and this fatal error vitiated their results and clouded their reasonings. A somewhat narrow and rigid application of Continental or English standards, in which three classes of rocks, the Primitive, Transition, and Secondary, figured, led to a grouping of rocks whereby even, according to the perspicacious estimates of Prof. Eaton, the coal-measures were brought within the limit of the State and the western rocks lifted above their natural plane, and made to occupy the enforced position of secondary strata instead of being shown to be the best exposure of palæozoic rocks known anywhere.

According to the system for the division of labor on the survey, the western parts of the State, whose monotonous regularity repelled the eruptive and catastrophic notions of the day, and which yet formed the best and most instructive standard to which more entangled and complex formations could be referred, was allotted to Lardner Vanuxem; the central portions to T. A. Conrad; New York Island, Long Island and the Hudson River to Lieut. Mather; and the Adirondacks to Dr. Ebenezer Emmons. Prof. Vanuxem was repelled by the uniformity and barrenness of his section and willingly surrendered it to Prof. Hall, at that time a young man. Mr. Conrad became palæontologist of the survey and Prof. Vanuxem succeeded to his charge. Prof. Hall's attentive examination of his unattractive region revealed to him its geological importance as a key whereby he might solve the problems of geological sequence throughout the continent, and his provisional tabulation of the fossils inclosed in these strata afforded him a succinct rule whereby he could measure the succession and establish the character of distant formations. With Prof. Vanuxem he slowly formed a new table of formations, energetically established analogies with it in other States by personal observation or through correspondence, and finally brought it to the test of public criticism in the famous report on the fourth district, which is certainly an example of lucid exposition and fine writing.

Prof. Hall gradually passed into the directorship of the survey, and issued a constant stream of reports, memoirs, papers, and volumes, covering not only the work proper of the New York survey but a variety of similar work for Iowa, Wisconsin, and Canada. Throughout later years Prof. Whitfield became associated with Prof. Hall and left indelible marks of his artistic precision and zoological instinct upon the work of the survey.

Prof. Hall possessed unusual opportunities for collecting specimens at a time when the field was unworked, and the accumulated detritus of years lay untouched along the base of cliff and hillside. Industrial enterprises of considerable magnitude, as the opening of the Erie Canal, were being started, and the necessary diggings afforded him new chances to collect fine and well-marked specimens; in short he appeared at a time when the richest fruits both of material and fame were within the grasp of a strong-minded, educated, and enthusiastic man. His private cabinet contained hundreds of type forms, and collateral investigation in other States added to it rare and surprising beauties. It was a reservoir into which the whole watershed of geological exploration at that day poured its first and richest streams. His collection became an object of envy among collectors, and was coveted by the institutions of Europe.

In 1875 Mr. Hall sold it to the trustees of the Museum for $60,000, and for the first time in its history it is exhibited in an instructive and interesting manner, with all its varied wealth of species, genera, families, classes, and kingdoms of extinct animals.

The hall abounds in striking objects. Slabs of sandstone from an ancient seashore pitted with small shells past which fine lines and microscopic ridges sweep, as though just traced by a retiring wave, nests of quaint trilobites gathered together in graphic groups as they were buried upon the old sea bottom, ripples crystallized in rigid bars of quartzite, corals clustering in antler-like bunches torn from the reefs of preadamite oceans, long "straight horns"—the shelly incasements of extinct devil-fish—innumerable shells, plants, sponges, and exquisite stone lilies, whose sculptured calyces are like toy-boxes and their tressy arms like the fringes of a tassel.

In vertebrate remains the collection is poor; the superb cabinets of Marsh and Cope have no adequate rival in the fragmentary skeletons of a few lizards, sharks, peccaries, and tapirs. The skeletons of the moas, large extinct ostrich-like birds from New Zealand, and the restored Irish deer, with its palmate antlers scored by the deep furrows of its traversing blood-vessels, are the only striking and very instructive remains of vertebrate life. We miss those extraordinary exhibitions of the strange and uncouth fauna which inhabited the West when chains of fresh water lakes lay between the Rocky Mountains and the Sierra Nevada, whose exhumation and description has won for New Haven and Philadelphia an enviable celebrity. But in the profusion of forms from Silurian, Devonian, and Carboniferous seas there is a boundless wealth of curious and perplexing types. It is as if the bottoms of preadamite oceans had been hardened, broken into fragments, and laid out on shelves exposing the life that flourished upon them. The judgment of the old philosophers who saw in these simulacra of living things only the exuberant creations of a "lapidifying juice" is to-day reversed; they are the sign-manuals, the cartouches of the ages.

The last and highest floor of the Museum contains a series of rooms intended to receive and accommodate private scientific workers and their collections, work rooms for members of the Museum, and for libraries. The library of the N. Y. Academy of Natural Science is deposited here, and here also are the two handsome donations which form at present the library of the Museum itself—Dr. Jay's Conchological Works, presented by Miss C. Wolfe, and the Brevoort Library on Natural History, presented by Mr. R. L. Stewart. On this floor there is also a lecture room in which courses of lectures are given by Prof. A. S. Bickmore to the teachers of the public schools of New York city upon subjects of general scientific interest. Here also are deposited the collections of Mr. J. Terry and Mr. A. E. Douglas in American archæology. The seclusion and quiet of these rooms are very inviting and form a grateful retreat for the student who wishes special privileges of study, away from sight-seers, noise, and confusion; who can here admire and penetrate the "true inwardness" of a Cambrian trilobite, an octobranchiate cephalopod, or a polypetalous exogen, or follow in the libraries the evasive windings of specific synonomy.

In writing of an institution whose obvious merits outweigh all possible strictures that can be made upon it, we are apt to assume an absurd vein of self-congratulation and indefinite boasting. It, however seems likely that the Museum may assume a somewhat higher character than a mere repository of natural objects, though it must never be forgotten that this is its rudimentary office, and that their clear presentation is its first duty to the people and to itself. Its board of trustees may yet incorporate scientific forces of positive magnitude and momentum in its government, enlarge its libraries, establish lectureships under its auspices in the city, open free laboratories for practical study in the sciences illustrated on its floors, in fact actively enlarge and perpetuate its mission as a *teacher*.

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